THE

PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES

FOR THE YEAR

1929

VOL. LIV.

WITH THIRTY PLATES
and 211 Text-figures.

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CORRIGENDA.

Page 506, line 25, *for* rceorded *read* recorded
Page 586, line 4, for *Neompheria* read *Neoempheria*
Page 590, in first footnote, for *Heteropternus* read *Heteropterna*
Page 590, line 30, for *Ohahunea* read *Ohakunea*
Page 591, line 38, for (*Neuraltelia* Rond.) read (*Neuratelia* Rond.)
Page 591, line 40, for (*Paraneuroltelia* Landr.) read (*Paraneuratelia* Landr.)
Page 593, line 6, for *Atelia* read *Ateleia*
Page 609, line 4, for *Dziedzieckia* read *Dziedzickia*
Page 612, line 4 from bottom of page, for *Symplasta* read *Synplasta*
Page 663, line 5 from bottom of page, for *exarta* read *exarata*
Page 663, line 10 from bottom of page, for *B. arenarius*, *B. racemosus*, read *Bromus arenarius*, *Bromus racemosus*,

THE

PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES

MARINE BIOLOGICAL LABORATORY
WOODS HOLE
LIBRARY
MASS.

ANNUAL GENERAL MEETING.

WEDNESDAY, 27TH MARCH, 1929.

The Fifty-fourth Annual General Meeting was held at Macleay House, 16 College Street, Sydney, on Wednesday evening, 27th March, 1929.

Dr. W. R. Browne, President, in the Chair.

The minutes of the preceding Annual General Meeting (28th March, 1928) were read and confirmed.

PRESIDENTIAL ADDRESS.

During the past year the Society's record has been one of continued steady progress. The usual quota of monthly general meetings has been held, and there has been no falling-off either in the standard of the papers submitted or in the number of interesting exhibits. The variety of subjects dealt with by different authors indicates that research in many branches of natural science is actively proceeding among our members, and in so far as it provides opportunities for the reading and discussion of papers and facilities for their publication, our Society must be considered to be performing a useful function in the community.

At the Annual Meeting a year ago mention was made of the proposal to erect a Science House at the corner of Gloucester and Essex Streets. Since then the State Parliament has passed an Act to enable a grant of land to be made to the Royal Society, Linnean Society and Institution of Engineers in *fee simple* as tenants-in-common, but unexpected difficulties have prevented much further progress being made with the scheme.

To fill the vacancy caused by the death of Professor Launcelot Harrison, the Senate of the University of Sydney appointed Professor W. J. Dakin to the Challis Chair of Zoology. Professor Dakin is no stranger to Australia, since he filled the Chair of Biology in the University of Western Australia from the date of its foundation in 1913 until 1920. Thereafter he occupied the Derby Chair

of Zoology in the University of Liverpool, where he established a distinguished reputation as a zoologist. We welcome him to New South Wales, and hope that he will find in our State a fruitful and congenial field for his future labours.

In July last a scientific expedition, organized by a Committee of the British Association for the Advancement of Science to study the growth of coral and other problems associated with the Great Barrier Reef, arrived in Australia under the leadership of Dr. C. M. Yonge. The expedition has established itself on Low Island, 40 miles from Cairns, where its work is proceeding steadily and satisfactorily. The activities of the expedition cover a wide range, including a detailed study of the many aspects of the growth and development of corals, algae, and other reef organisms, the regular taking of series of hydrographic and plankton observations, investigations of the chemical and physical conditions of the sea inside the Barrier, and geographical studies of the Barrier Reef region. The results of this expedition will undoubtedly add very greatly to our knowledge of the conditions under which the Great Barrier Reef flourishes.

An event of note in scientific circles was the arrival in Sydney in February of the *Dana* Expedition. This voyage of the *Dana* has been planned for the further study of the natural history of the eel, a subject on which the leader, Dr. Johannes Schmidt, has for years been the highest authority. In carrying out this study the *Dana* Expedition makes the widest observations on the chemistry and physics of the oceans, collects extensively of the fauna and flora, and in fact carries out a very extensive and complete oceanographic survey of the regions traversed. The ship left Copenhagen in June, 1928, and after circumnavigating the world should return to Copenhagen some time in 1930. The collections and information obtained by the expedition should be of the greatest scientific value when they have been handled by experts in the several branches. Dr. Schmidt's party will be accompanied, either for part or all of the voyage, by Dr. P. Jesperson, Dr. Th. Mortensen, Prof. Ove Paulsen and Dr. J. N. Neilson. The oceanographic survey being conducted by the *Dana* is perhaps the most important and extensive since that carried out by the *Challenger* Expedition a little more than fifty years ago.

The announcement that the Federal Government has decided to organize and equip a scientific expedition to that part of Antarctica lying immediately to the south of Australia will be welcomed by all interested in the scientific problems of the Antarctic. That the expedition is to be under the leadership of Sir Douglas Mawson, who already has a wide experience of Antarctic exploration, should engender a feeling of confidence in the ultimate success of the venture. As the result of the Australasian Antarctic Expedition of 1911-14, under the leadership of Sir Douglas Mawson, we already have considerable knowledge of the region to be visited, and the proposed expedition should be able to fill in many of the gaps and make valuable additions to what is already known of this inhospitable but increasingly important region. It is proposed to carry out exploration and mapping of portions of the coastline, as well as meteorological observations, and investigations of the fauna of the region—especially whales and seals. We look forward to another interesting chapter in the annals of Antarctic exploration.

The Australian Association of Simplified Practice has formed a Committee to draw up a schedule of Standard Typography for scientific and educational publications. While there is much to be said in favour of some expression of individuality in publication, there are many directions in which this Committee

can be of material help to the many honorary editors of the publications of scientific societies and institutions.

At the April meeting we had the pleasure of welcoming Professor T. D. A. Cockerell of Colorado University, who gave us a short address on "Wild Bees", a subject on which he is a recognized world authority.

Since the death of Dr. R. Greig Smith in August, 1927, the Society has been without a Bacteriologist. During 1928 the Council advertised the position throughout Australia and New Zealand, as well as in England, and in response received three applications. The supply of research bacteriologists is very limited, and the probability had been realized that there would be very few applicants for the vacant position. The Council, after due consideration, appointed Mr. H. L. Jensen to be Macleay Bacteriologist to the Society. Mr. Jensen is a Danish subject, and a graduate of the Royal Agricultural and Veterinary College, Copenhagen. In 1923 he was appointed Assistant in Research at the State Laboratory of Plant Culture at Lyngby, Denmark, working under the late Dr. H. R. Christensen and Professor K. A. Bondorff until October, 1927, when he was awarded an International Education Board Fellowship to carry on post-graduate research on Soil Bacteriology at Rothamsted Experimental Station. His research includes work on the protozoan fauna of the soil and its functions, on bacteriological methods of studying soil-fertility, on the influence of the carbon-nitrogen ratio of organic materials on the mineralization of nitrogen, and on the fungi of Danish soils. At Rothamsted he has been studying the microbiology of farmyard-manure decomposition in soils, with special reference to the decomposition of lignocellulose and of dead microbial protoplasm in relation to humus formation. The general subjects of the research which he proposes, as Macleay Bacteriologist, to conduct are: (i) The influence of irrigation on the microflora of the soil; (ii) the existence of culturally and serologically different groups of nodule bacteria of leguminous plants; and (iii) the oxidation of iron pyrites by sulphur bacteria.

Mr. Jensen comes to us highly recommended by his teachers and by Sir John Russell, Director of Rothamsted Experimental Station, and we look forward to an active resumption of bacteriological work on his arrival, about the beginning of September next.

The concluding part of Volume liii of the Society's PROCEEDINGS has been issued. The complete Volume (662 plus lxxxvi pages, 40 plates and 173 Text-figures) contains thirty-eight papers from twenty-two authors, ten of the papers being contributed by past and present Linnean Macleay Fellows. At this time last year there was a large accumulation of papers held over from 1927, but the decision of the Council to increase the number of Parts of the PROCEEDINGS issued in a year allowed this accumulation to be overcome, and it will probably be some years before we shall again find it necessary to hold papers over from one year to the next on account of lack of space in the Volume.

In addition to the PROCEEDINGS for the year there has been issued an index to the first fifty volumes of the PROCEEDINGS. The index contains (i) an alphabetical list of contributors to the PROCEEDINGS, with the titles of papers and reference to year and page; (ii) a subject index compiled from the titles of the papers; (iii) an alphabetical list of exhibitors of specimens, etc., at the meetings of the Society; and (iv) an index to the obituary notices which have appeared in the PROCEEDINGS. I think you will agree with me that our Secretary is to be congratulated on an exceedingly fine piece of work. The index has already

proved its usefulness, and should become increasingly valuable as an easy and rapid means of tracing papers in the volumes of PROCEEDINGS.

Exchange relations with scientific societies and institutions continue satisfactorily. The receipts for the year total 1,777, as compared with 2,540, 1,821 and 1,409 for previous sessions. During the year the following societies and institutions have been added to the exchange list, which now numbers 214: Royal Botanic Garden, Edinburgh; Geological Society of Peru; Botanical Society of Bulgaria; Geological Survey of Kwangtung and Kwangsi; Bulgarian Society of Natural Sciences; Department of Agriculture, Industry and Commerce, Buitenzorg; "Lotos"; The Science Society of China, Nanking; and the Institute of Geology, Shanghai.

The death, on 21st February, 1928, of Professor L. Harrison, who had been nominated by the Council as President for 1928-29, and also as a member of Council, rendered necessary the election of President and a member of Council at a Special Meeting, which was held immediately after the last Annual General Meeting. The result was the election of Assistant-Professor W. R. Browne, D.Sc., as President and of Dr. I. M. Mackerras as a member of the Council.

The vacancy on the Council caused by the death of Mr. R. H. Cambage was filled by the election of Professor T. G. B. Osborn, D.Sc.

On account of his appointment to the staff of the Department of Economic Entomology of the Council for Scientific and Industrial Research, Dr. G. A. Waterhouse tendered his resignation as Hon. Treasurer. The Council regretfully accepted this resignation, but Dr. Waterhouse has been able to retain office as a member of Council, and we may express the hope that it will be some time before his duties in his new position make it necessary for him to relinquish his active association with the management of the Society's affairs. The Hon. Treasurer's mantle has fallen on the broad and capable shoulders of Mr. E. Cheel, whose knowledge and wide experience as a man of affairs should do much to maintain the Society's finances in their present very satisfactory condition.

To the meeting of the British Association for the Advancement of Science, to be held in South Africa next July, the Society's Secretary, Dr. A. B. Walkom, has received the honour of an official invitation, accompanied by an offer of a substantial contribution towards expenses. Even a short visit to South Africa would afford some opportunity for a comparative study of the palaeobotany of a continent which, geologically, has much in common with our own, and the Council has gladly agreed to grant Dr. Walkom the necessary leave of absence to enable him to accept the invitation.

I have much pleasure in offering the Society's heartiest congratulations to:

Mr. E. C. Andrews, on his election as President for 1929 of the Australasian Institute of Mining and Metallurgy; Sir Douglas Mawson, on his selection as leader of the proposed Commonwealth expedition to the Antarctic; Professor Griffith Taylor, on his appointment to a Chair of Geography at the University of Chicago; Dr. G. A. Waterhouse, Dr. I. M. Mackerras and Mr. T. G. Campbell, on their appointments to the staff of the Division of Economic Entomology at Canberra; Messrs. C. Barnard and I. V. Newman, on their attainment of the degree of Master of Science of the University of Sydney; Mr. W. R. B. Oliver, on his appointment as Director of the Dominion Museum, Wellington, N.Z.; and Mr. H. M. Hale, on his appointment as Curator of the South Australian Museum.

During the past few years the Society has lost by death a number of members who, in addition to rendering valuable services to the Society, have achieved world-wide reputations for their scientific work. In order that there may be some permanent record of appreciation of such members the Council has decided to institute a series of memorials to distinguished members of the Society who have died since 1st January, 1925, each memorial to take the form of a biography, with portrait, bibliography and other suitable matter, and to be printed in the PROCEEDINGS as well as separately for private distribution. It was decided that memorials be prepared of the following distinguished members: Mr. R. H. Cambage, Mr. J. J. Fletcher, Professor W. A. Haswell, Mr. C. Hedley and Mr. J. H. Maiden. The memorial of Professor Haswell appeared in the PROCEEDINGS for 1928, and the appreciation of Mr. Fletcher, published in the PROCEEDINGS for 1927, will form part of the memorial to him. The others are in course of preparation.

During the past year eight persons were elected to ordinary membership of the Society, three members resigned and five died, the number of ordinary members remaining at 168. The losses by death were B. Bertram, R. H. Cambage, J. Hopson, Jr., C. T. Musson and W. Welch.

BERT BERTRAM, who died at Albury in July, 1928, had been for only a few months a member of the Society. He had contributed one paper to the PROCEEDINGS, dealing with the measures taken in controlling the mosquito in the Municipality of Lane Cove, Sydney. He took a very active interest in methods of preventing the spread of mosquitoes and had done much valuable work in this direction.

RICHARD HIND CAMBAGE, who died suddenly at his home, "Wyaglan", Park Road, Burwood, on 28th November, 1928, was born at Milton, N.S.W., on 7th November, 1859. He was trained as a surveyor, and joined the Public Service in 1882, serving for three years as a draughtsman in the Department of Lands. In 1885 he was appointed Mining Surveyor in the Department of Mines, and in 1902 became Chief Mining Surveyor, which position he held until his appointment as Under-Secretary for Mines on 1st January, 1916. He retired from the Public Service on 7th November, 1924. From 1903 to 1918 he was a member of the Licensed Surveyors Examination Board, and from 1909 to 1915 Lecturer on Surveying at the Sydney Technical College. He was an energetic worker in scientific societies and held many high offices, among them being: 1907-1909, President of the Institute of Surveyors; 1913, President of the Wild Life Preservation Society; 1912 and 1923, President of the Royal Society of New South Wales; 1924, President of the Linnean Society of New South Wales; 1926-28, President of the Australian National Research Council; 1928, President of the Australasian Association for the Advancement of Science and President of the New South Wales Branch of the Australian Forest League. He was Honorary Secretary of the Australian National Research Council from its inception in 1919 till 1926, and of the Royal Society of New South Wales from 1914 till 1928 (with the exception of the years 1923 and 1924). He was also for some years a Trustee of the Australian Museum. As Honorary Secretary of the Australian National Research Council he had the onerous duty of organizing the Second Pan-Pacific Science Congress held in Melbourne and Sydney in 1923. His voluntary work for the scientific societies of New South Wales was invaluable, and his place will be very hard indeed to fill. But his participation in the administration of scientific affairs represented only a portion of his contribution towards the advancement of Science in Australia, for

he was a recognized authority on more than one branch of botanical science. His knowledge of the native flora extended to almost every part of the Australian continent, and it is probably safe to say that few, if any, botanists of the present generation could boast such an intimate acquaintance with the flora of so large an area. His knowledge was especially outstanding as regards the genera *Acacia* and *Eucalyptus* and the endemic plant-assemblages peculiar to this island-continent. He contributed to our PROCEEDINGS eighteen papers dealing with local developments of the flora in districts which he visited chiefly in the discharge of his official duties as Mining Surveyor.

For many years he systematically planted seeds of species of *Acacia* and noted his observations on the growth of the seedlings. He aimed at completing the description of ten seedlings each year, and up till the time of his death had published in the *Journal of the Royal Society of New South Wales* thirteen papers containing descriptions of 130 species. The work on a number of seedlings which he had under observation is being carried to completion at the Botany School of the University under the care of Professor Osborn. He took a keen interest in the question of the preferences exhibited by species of plants for certain types of soil, and missed no opportunity of making observations relating thereto. He had not published much on this subject, but referred in general terms to it in his Presidential Address to us in March, 1925. He had also given much thought to the problem of the origin of the Australian flora, and outlined some of his conclusions in his Presidential Address to the Australasian Association for the Advancement of Science at Hobart in January, 1928.

To the work of the Royal Australian Historical Society he made useful contributions by tracing out the journeys of early explorers. The journals left by the explorers did not always indicate the exact path they followed, but Mr. Cambage with his knowledge of bushcraft, perfected by his wide experience as a surveyor, took a delight in trying to follow, step by step, the journeys of some of the explorers, and on account of his training he succeeded where many others must have failed.

A member of our Society from 1899, he was elected to the Council in 1906, and was President in 1924. Besides contributing papers to the PROCEEDINGS he took a prominent part in the meetings of the Society. He also contributed twenty-nine papers to the *Journal of the Royal Society of New South Wales*. He was a Fellow of the Linnean Society of London, and was created C.B.E. in 1925.

His death came very suddenly, taking place only a few days after he had attended a meeting of our Council. He will be sadly missed by all his colleagues and friends, for he possessed to a rare degree the qualities of tact, moderation, charitable judgment and geniality, which made him beloved by all who knew him. The Council has resolved to have a memorial of him prepared for inclusion in the Memorial Series, where it will appear at a later date.

JOHN HOPSON, Junior, was born on 30th December, 1867, and lived all his life at Eccleston, where he died on 17th June, 1928. His school education was limited, being confined to that obtainable at small country schools and crammed in between the calls of life on a farm. His love of nature and close powers of observation, however, gave him that wider and fuller education which brings so much satisfaction to the dweller in the country. He was interested chiefly in insects and birds, though he also had a wide knowledge of the plants of his district. He was very closely associated with the development of Barrington

Tops, and had attended all the scientific excursions to that district since 1915. During these excursions he rendered the greatest assistance to visiting scientists, and at all times was his help particularly valuable and welcome to biologists. His collecting was chiefly entomological, and many new forms were submitted by him to some of our members, especially the late Dr. E. W. Ferguson and Mr. H. J. Carter. He took an interest in all the affairs of the district where he lived, and was President of the local Farmers' and Settlers' Association, which later became the local branch of the Agricultural Bureau. For more than forty years he was a leader in the Eccleston Congregational Church, where at the time of his death he was a lay preacher. He had been a member of this Society since 1918, and we occasionally had the pleasure of meeting him when his visits to Sydney coincided with a meeting of the Society.

Charles Tucker Musson, who died at Gordon on 9th December, 1928, was born on 14th December, 1856. He was the eldest son of Robert Mackley Musson, of Park Valley, Nottingham, and was educated at the Nottingham Grammar School. At an early age he showed a taste for nature-study and began by collecting, mounting and classifying land and fresh-water shells and collecting and painting fungi. Before he came to Australia in 1887 he had made two very fine collections of shells, one of which was presented to the Nottingham Museum. He attended lectures on botany at Nottingham University, and spent most of his holidays roaming Sherwood Forest and the Dukeries collecting plants. For several years prior to his departure for Australia he lectured on Botany at Nottingham.

With his mother he came to Australia in 1887 and for a time assisted his brother-in-law, Mr. G. H. Pigott, in business at Narrabri, where he soon became very interested in native trees and grasses. Soon afterwards he was appointed Science Master at the Hawkesbury Agricultural College on its foundation in 1891, and served there continuously until he retired in December, 1919. During this long period his sympathy and enthusiasm, as well as his skill as a teacher, stimulated the interest of the large number of students who passed through his classes, and also of the many teachers who attended summer schools at the College. He joined this Society in 1888, soon after his arrival in Australia, and continued his membership till his death. His earlier contributions to the Proceedings comprised three papers (two of them in collaboration with the late Charles Hedley) on Mollusca (1890, 1891) and some notes on the dispersal of species of plants; later he was associated with the late J. J. Fletcher in some work on shoot-bearing tumours in Eucalypts and Angophoras, and with W. M. Carne on adventitious roots in *Melaleuca linariifolia*.

William Welch, who died at Cremorne on 5th April, 1928, was born at Portsmouth in 1850. Before migrating to New Zealand in 1884, he was for some years attached to the Admiralty. As a result of his interest in general scientific matters he was instrumental in founding the Museum at Palmerston North, N.Z., and also the Philosophical Society at Manawatu. He was interested in geographical and anthropological matters, particularly Maori customs, and several times visited Australia to attend meetings of the Australasian Association for the Advancement of Science. He came to Sydney in 1906. He joined this Society in 1916, and although he made no written contribution to the Proceedings he was for a number of years regularly present at the monthly meetings until indifferent health prevented his attendance. He took an active interest in the Royal Australian Historical Society, of which he was Honorary Treasurer for twelve years, ill

health forcing his resignation in 1927. He was also for a time Honorary Secretary of the branch of the British Science Guild in Sydney.

The year's work of the Society's research staff may be summarized thus:

Miss Ida A. Brown, Linnean Macleay Fellow of the Society in Geology, has spent a considerable portion of the past year in the field, in the Tilba-Mt. Dromedary district and also west and south of Moruya. She completed her geological mapping in the Mt. Dromedary area, and made preliminary examinations of the fossiliferous sediments in the neighbourhoods of Cobargo, Quaama, Bermagui, Eden and the Clyde Mountain. She also gave some attention to the Tertiary and more recent formations along the coast, including the first known evidences of marine Tertiary sedimentation in eastern New South Wales. As a result of this work she is preparing a second paper on the geology of the South Coast, the first, dealing with the Palaeozoic geology, having been published in Part 3 of the PROCEEDINGS for 1928. This second paper will give an account of the Tertiary sediments and basalts, later tectonic movements and the development of the present physiography. Another paper in preparation deals with the geology of the Tilba-Mt. Dromedary district, essentially a study of an intrusive series of plutonic and hypabyssal rocks of a monzonitic character, ranging from ultrabasic to acid types, and including some rare types not hitherto known to occur in Australia. A preliminary note on this series of rare types has been prepared and will appear in Part 2 of the PROCEEDINGS for 1929. Two other papers, one on the occurrence of a garnet-bearing dyke near Moruya and the other (in collaboration with Mr. W. S. Dun) on an occurrence of varieties of *Spirifer disjuncta*, are almost complete.

During the coming year Miss Brown proposes to continue her investigations on the geology of the South Coast, paying special attention to the problems of the geological age, conditions of sedimentation, mutual relationships and subsequent tectonic history of the sedimentary rocks, and the relationships, petrogenesis and correlation of the associated igneous rocks, chiefly south of Mt. Dromedary.

Miss H. Claire Weekes, Linnean Macleay Fellow of the Society in Zoology, has continued her studies on placentation in reptiles, with the object of giving systematic accounts of placentation in as many viviparous snakes and lizards as she is able to collect, and finally of giving a general account of placentation among the Reptilia. She has completed the examination of the phenomenon in the two snakes *Denisonia superba* and *D. suta* and one lizard, which was thought to be *Lygosoma pretiosum* but has proved to be a new species. These results are embodied in a paper "Placentation in Reptiles, No. i", which will appear in Part 2 of the PROCEEDINGS for 1929. In order to obtain additional material Miss Weekes collected over a large part of north-eastern New South Wales, with disappointing results. She then visited Tasmania and collected specimens of four additional species of viviparous lizards belonging to the genus in which she is interested. These will provide material for the continuation of her studies during the coming year.

Four applications for Linnean Macleay Fellowships, 1929-30, were received in response to the Council's invitation of 26th September, 1928. I have pleasure in reminding you that the Council re-appointed Miss Ida Alison Brown and Miss Hazel Claire Weekes to Fellowships in Geology and Zoology respectively for one year from 1st March, 1929, and in wishing them a successful year's research.

An Outline of the History of Igneous Action in New South Wales till the Close of the Palaeozoic Era.

(Plate A.)

Introduction and Acknowledgments.

In this second part of my address I propose to lay before you some account, necessarily very imperfect and incomplete, of igneous activity in this State from the earliest times down to the close of the Palaeozoic Era, recounting the various eruptive episodes, both intrusive and extrusive, of which we have knowledge.

Such an account must inevitably be based largely on the results of other men's labours, and for the purposes of this address I have made free use of published reports and papers by many workers, especially by the officers of the Geological Survey. But apart from the written word I have leaned heavily upon my colleagues in the Geology Department of the University and my good friends of the Geological Survey, and for their help, given without grudge and without stint, I wish to render grateful thanks. Through the kindness of the Acting-Curator of the Mining Museum I have had access to the slide-collections of the Geological Survey, a rich and precious treasure-house of good things petrological, both new and old, and of this valued privilege I am deeply appreciative.

Of late years attempts have been made with considerable success to link up the eruptive episodes in the earth's history with the various tectonic events in what is known as the geological cycle. According to Joly (1925) and other authorities this cycle may be regarded as consisting of four phases. If we consider it as commencing with a continental surface which has reached the peneplain stage, the first phase is characterized by a series of transgressions of the sea over the land-surface, alternating with retreats; this passes into the geosynclinal phase during which prolonged crustal sagging is accompanied by heavy sedimentation. Near the end of this phase there is a tendency towards re-emergence of the land, but this is overshadowed and deposition is stopped by the folding of the sediments. To this folding there succeeds a period of vertical uplift and continent-formation, with resultant prolonged denudation of the land-surface.

Among British geologists Dr. Harker of Cambridge (1909, 1917) has been perhaps the most constant and consistent advocate of the doctrine that the various kinds of crustal movement are intimately bound up with special types of igneous activity, and his conclusions have been in general confirmed and extended by the work of other investigators. It may now, for example, be regarded as an established fact that the intrusion of bathyliths, usually of a granitic character, is a frequent accompaniment of orogenetic movements, that the vertical movements succeeding the folding phase of the geological cycle are often followed by the extravasation of great sheets of basaltic lava, and to a less degree of alkaline rocks, upon the continental surface, and that submarine volcanic activity, often resulting in rocks of spilitic affinities, is very common during the progress of geosynclinal sedimentation (Tyrrell, 1926).

In tracing the history of igneous action in this State it is my intention, not merely to recount the various events so far as we know them, but also to try and correlate them with the various tectonic episodes recorded in the strata. The geographical boundaries that I set myself are of course man-made and unnatural, but that is in the nature of things almost inevitable; the stratigraphical limits

have been imposed by the necessity of keeping this address within reasonable bounds of both time and space.

If it appears that special emphasis is being laid on the intrusive as contrasted with the extrusive phases of eruption, I would remind you that the sequence of the purely volcanic outbursts has recently been dealt with by Mr. C. A. Sussmilch (1923), so that it is unnecessary for me to traverse in detail the ground covered by him, except where more recent work has amplified our knowledge. On the other hand, except for brief though valuable summaries by Mr. E. C. Andrews (1914) and Mr. Sussmilch (1914), we have no chronological account of the many plutonic igneous intrusions of the State, and it does seem that their great and many-sided importance is sufficient justification for an attempt to bring together the scattered information about them and write a connected story.

The all-important task of determining the geological age of igneous rocks is, for the purely volcanic products, often comparatively simple, since they are in the main associated with sedimentary strata of determinable stratigraphical position, but in the case of the plutonic rocks, which appear at the surface only as the result of deep denudation of the original sedimentary cover, the fixing of the geological age of an intrusion with any degree of accuracy may be extremely difficult, and even impossible. Three principal means to this end lie open to us. In the first place an extended field-survey may reveal outcrops of the same mass elsewhere in such association with sediments as permits of fairly exact age-determination; secondly, the intrusion may occur in a region which, from other evidence, is known to have suffered folding only at one particular epoch, and to that epoch the intrusion may be confidently assigned; and lastly, correlation with other intrusions of determinable age may be possible through internal evidence, such as chemical, mineralogical or even textural peculiarities, or through the nature of the associated ore-deposits, which are really themselves the expressions of special magmatic characteristics. By these means, used separately or in conjunction, the age of an intrusion may often be fixed within quite narrow limits.

Pre-Cambrian.

The earliest sedimentation of which we have any record in New South Wales is that which is represented at the present day by the Willyama metamorphic series of the Barrier Ranges, now regarded as being of Archaean age (Andrews, 1922). Among the highly-folded strata exposed at the surface there have been found no indications whatever of contemporaneous vulcanicity, nothing corresponding, for instance, to the Keewatin lavas of North America, or the Older Greenstones of Kalgoorlie, W.A. Evidence of igneous activity preceding the folding and metamorphism of the series is, however, present in the form of ophitic dolerites, probably originally belonging to the quartz-dolerite suite, forming sills or dykes, remnants of which are preserved in the form of thermally-altered inclusions in granitic gneiss (Browne, 1927).

The folding and intense metamorphism of the Willyama Series was followed or accompanied by a period of igneous injection, during which dynamic pressure was still active. The results are seen in lens-like, sill-like and perhaps phacolithic sheets of no great width, composed of primary granite-gneiss, pegmatite and gabbro. Amongst the earliest of the intrusions is a peculiar fine-grained acid granite, with pegmatitic phases, in which cordierite assumes the rôle of primary ferro-magnesian constituent. The incorporation in this rock of sillimanite from the invaded paragneisses has given rise to some curious hybrids. The biotite-granite-gneisses

are in part porphyritic, and show the effects of differentiation in the presence of more basic phases of the nature of biotite-quartz-diorites, as well as of contemporaneous acid or aplitic modifications of which cordierite is an occasional component. Garnet appears in some phases of the gneiss, possibly in part derived from the invaded paragneisses but possibly also to some extent magmatic (infraplutonic) in origin, and a rather decomposed allanite is a minor but very constant constituent.

More extreme differentiation, perhaps of a complementary type, is indicated by dykes of hornblende-hypersthene-gabbro through the granite-gneiss, and these, with cross-dykes of pegmatite and little bosses of massive fine-grained granite, afford evidence that intrusion continued after the compressional had given place to tensional stresses.

Comparable in extent and importance with the granite-gneisses is the great series of sill-like sheets of hornblende-gabbro and norite, passing in places into hornblendite, and altered through local shearing to hornblende-schists, while innumerable great sills of pegmatite, mostly in the country to the west of Broken Hill, may represent complementary acid differentiates from the original magma that underlay the region. Probably, too, the masses of serpentine, which shows traces of brown hornblende and bastite, may represent an ultrabasic phase of the gabbro magma. For the most part the gabbro-intrusions would appear to be later than the granite-gneisses, but certain basic intrusions now considerably metamorphosed may have been earlier, and the presence in the granite-gneisses of certain curious rocks containing much quartz as well as much hornblende and epidote, suggests the partial digestion by the granite magma of pre-existing basic rocks.

A series of fine-granular rocks, with very high silica percentages and containing, in addition to much quartz, basic plagioclase, biotite and occasional garnet, have been the subject of much discussion. They are generally referred to as "quartzites," but on their field-occurrence and relations, as well as on the occasional presence of primary gneissic banding and other internal evidence, it is probably more correct to assign to them an igneous origin.

That the intrusion of the granite-gneisses post-dated the metamorphism of the invaded sediments is clear from the frequent inclusion in the igneous rocks of lenticles of sillimanite, and the interleaving of gneiss and schist along the margins of the intrusions. Indeed, so intimate is the blending that boundaries have in places proved difficult to define, and doubt has even been cast on the igneous nature of certain gneisses, on account of their apparent passage outwards into schists and paragneisses.

It is perhaps noteworthy that, though very evidently connected with the diastrophism that closed the period of deposition of the Willyama Series, the masses of magma that were injected took the form, not of bathyliths, but rather of concordant intrusions, such as one expects to find in regions of tension. Whereas, however, the normal sill and laccolith, at the time of their formation, usually have their shortest dimension vertical or nearly so, in these orogenic sills and lenses the magma has been forced more or less vertically upwards, and the shortest axis of the mass has therefore always been horizontal, except where deformation of the strata during crystallization of the magma has caused deflection.

A further igneous episode is represented by the Mundi-Mundi granite, a massive, rather acid type with pegmatite, which forms a series of sills or intrusive sheets with an alignment showing a general parallelism to the grain of the country;

these granites outcrop well over to the west of the main gneiss-intrusions. According to Mawson (1926), very similar granites outcrop about sixty miles to the west at Boolcoomatta in South Australia, and some of the rocks of this locality are strongly titaniferous, thus possibly linking the Mundi-Mundi rocks with those of Benson's (1909) South Australian "Houghton magma" of pre-Cambrian times. Very probably associated in time with the granites are a series of dolerite-dykes cutting across the grain of the Willyama schists and extending as far as Broken Hill. These are now for the most part altered to epidiorites, and include both olivine-bearing and olivine-free types. A somewhat similar series is in evidence at Boolcoomatta.

The Mundi-Mundi intrusions are certainly much younger than the granite-gneisses, and it is highly probable that they belong to an orogenic epoch quite distinct from, and later than, that which put a period to the Willyama sedimentation, though still pre-Cambrian.

The Broken Hill lode, and the other rock-types specially associated with it, such as the green-felspar-pegmatite, the mangan-hedenbergite pyroxenite, the so-called garnet-sandstone and the quartz-garnet-magnetite-apatite rocks, are regarded by Mr. Andrews as very specialized differentiates from the older or Willyama magma.

The area covered by Archaean and Early Proterozoic (?) rocks in this State is relatively small, being confined to the region of the Barrier Ranges. On all sides the rocks dip away under recent alluvium, except to the north where they are overlain unconformably by the Late Proterozoic tillites, limestones and other sediments. Among these no igneous rocks of any kind have been observed.

Ordovician.

Of Cambrian sedimentation no recognizable record has been found in this State. It is true that there are in several places schistose rocks which show a gradual and conformable passage into graptolite-bearing slates of Ordovician age. No fossils have been discovered in the schists, but, inasmuch as no angular unconformity separates the Ordovician and Cambrian systems in most parts of the world, the necessity for caution in the classifying of these schistose rocks has been repeatedly urged (Andrews, 1914, 1915*a*). However, for present purposes, this caution may be disregarded, since the definitely schistose series do not comprise, so far as is known, any volcanic material, and the granitic rocks intrusive through the folded schists are not likely to be older than late Ordovician.

Although Upper Ordovician formations have been known in this State for more than thirty years, no detailed studies of their lithology have been undertaken. Sussmilch (1923) has called attention to the virtual absence of volcanic material among the Ordovician rocks and, in fact, though these have a wide distribution through the State, such records of eruption as we possess are confined to a belt of country extending from Parkes and Forbes eastwards through Mandurama, Cadia and Carcoar to Newbridge. From among the Ordovician strata at Parkes and Forbes tuffs and contemporaneous andesitic and basic amygdaloidal lavas have been described (Andrews, 1910). The tuffs consist mostly of quartz and albite, while the lavas include albite-keratophyres and hornblende- and augite-andesites, now completely albitized and otherwise altered. From Forbes have been obtained granophyric soda-aplite and a fine-grained albite-granite, both evidently intrusive, though their exact relationships with the volcanic rocks are not known.

At Mandurama and Lyndhurst (Pittman, 1900) radiolarian cherts of Ordovician age are interstratified with beds and thin layers of tuff, and associated hornblende-augite-andesites are completely albitized, with concomitant production of epidote and chlorite. A porphyritic quartz-keratophyre comes from Cadia, where, as at Carcoar, andesitic flows, much altered, have been noted among the Ordovician strata (Jaquet, 1901). The occurrence of altered andesites has also been recorded from Newbridge (Benson, 1907).

The only other known example of a probable Ordovician alkaline rock comes from the south-eastern part of the State, on the Snowy River near the Victorian border. It is a quartz-keratophyre tuff, slightly recrystallized, probably as a result of the presence of an intrusive mass of granite.

According to Harper (1909*a*) the Ordovician series around the Upper Macquarie Valley includes acid tuffs and highly crushed quartz-porphyries which may represent contemporaneous lava-flows; and similar rocks have been obtained from Newbridge. Among strongly-folded slates of probable Upper Ordovician age outcropping to the north of Cooma there are somewhat schistose gritty rocks which may be sheared acid tuffs, as well as a series of schistose potash-rhyolites or rhyolite tuffs, particularly well developed at Bredbo, twenty-one miles north of Cooma; but the most persistent and uniform igneous group, which has been traced for almost fifty miles, is that of the schistose quartz-porphyries, resembling closely some of the Tasmanian porphyroids, which represent, in part at least, contemporaneous sill-intrusions into the Ordovician strata. They are conceivably comagmatic with the rhyolites and with the granite-gneisses presently to be described, and may be the equivalents of the similar rocks outcropping along north-and-south belts to the west of Bathurst and the west of Orange respectively.

The diastrophism which marked the close of the Ordovician period was, with the exception of that which closed the Willyama sedimentation, the most intense that has been experienced in New South Wales, just as it was in Queensland, Victoria and Tasmania. Great thicknesses of sediment had been accumulated, under deep-water marine conditions for the most part, and when a violent diastrophic period was put to deposition the rocks were in many places highly crumpled and folded, and converted into slates, phyllites and schists. Strangely enough, so far as we are aware, there was comparatively little in the way of igneous activity connected with these disturbances, but of course the paucity of outcrops may be due to there having been up to the present insufficient denudation to expose the granitic cores in the belts of greatest metamorphism. However, the little that has been revealed to us is of surpassing interest.

At Cooma (Browne, 1914) the transition from graptolitic slates through phyllites into mica-schists may be clearly traced, and these schists in their turn pass into others which have been impregnated and injected by an acid two-mica granite, obviously introduced some time after the commencement of diastrophism, when regional metamorphism had been accomplished, but compression was still affecting the terrain. Two phases of granitic invasion seem to be indicated, the first expressing itself in sporadically-distributed patches and lenses of gneiss with a characteristic mottled appearance; this, by its field-relations, is igneous, but always contains the minerals andalusite, sillimanite and cordierite, a strange assemblage in such a rock, and explicable only on the assumption of much assimilation of sedimentary material by the granitic magma. The second gneiss, of which the first may be merely a modification, frequently contains cordierite and

sillimanite, and is in some places massive, but elsewhere well-banded. Closely associated with it are dykes of tourmaline-pegmatite and masses of hornblende-gabbro, apparently complementary rocks. Though making a continuous outcrop around Cooma, to the west and north the intrusion appears as a succession of tongues or sills intimately interleaved with the schists, the whole extent of outcrop and impregnation zone being almost six miles from east to west and not less than twenty miles from north to south, the further meridional extension being obscured by later formations.

The primary gneissic banding, intimate penetration of the country-rock, with assimilation, granitization and *lit-par-lit* injection on such a scale as to render the drawing of geological boundaries difficult, the association of consanguineous extremes in pegmatite and gabbro, and lastly, the marked elongation of the zone of injection parallel to the strike of the country and the general effect of concordant injection in the main mass and the satellitic sheets—all these together form a perfect and impressive illustration of the effects of the intrusion of magma under abyssal conditions amid folded sedimentary rocks at a high temperature and still under the influence of compressional forces. It was no doubt occurrences of this kind which mystified our geological forebears, and gave rise to such conceptions as that of the metamorphic origin of granite and its formation by the fusion of sediments.

There is at Albury another area of schists and phyllites which form the northerly continuation of those described by A. W. Howitt (1887) many years ago from the Omeo district in Victoria. The Albury schists are injected by acid granites containing sillimanite, with associated tourmaline-pegmatites. The granite is very similar to that of Cooma, though not conspicuously gneissic, and from Howitt's descriptions it is evident that in the Omeo district the conditions at Cooma are reproduced very closely, including the gradual passage of the schists outwards into Ordovician graptolite-slates.

Silurian.

Succeeding the intense diastrophism that closed the Ordovician period, it would appear that continental conditions prevailed in this State for a long time during the deposition of the Lower Silurian strata in Victoria. The continental deposits, if any, produced during this epoch appear to have been removed by erosion before subsidence recommenced. It is possible that the dykes of dolerite and albitized andesite which are recorded as intersecting the Ordovician but not the Silurian rocks of the Cargo (Andrews, 1915*b*) and Forbes-Parkes districts, belong to this continental epoch.

Upper Silurian sedimentation was of the continental-shelf type, resulting largely in the laying down of shales and limestones, with sandstones, grits and conglomerates near the coast-lines. In a number of places where shallow-water conditions prevailed there was contemporaneous vulcanicity, expressed in tuffs and lava-flows.

The Florida rhyolites of the Cobar-Canbelego area are regarded by Andrews (1915*a*) as a series of submarine flows initiating the Silurian sedimentation there, though the hypothesis of sub-aerial deposition during early Silurian times does not seem untenable. Attention has been drawn to the remarkably high alkali-content of the series, the rocks of which are very siliceous and include both orthoclase- and albite-bearing types. About the Bald Hills, to the north of

Canbelego, and apparently also in the Silurian series, are outcrops of spilitic basalt, and the association of these and the quartz-keratophyres in the same series with radiolarian cherts may, as Andrews points out, have some genetic significance.

Much further to the east, in the Forbes-Parkes goldfield, the Silurian sandstones, shales and limestones have among them tuffs and flows or sills of porphyritic augite-andesite almost completely albitized; some of the associated sediments are described as cherty claystones, but no radiolaria have been recorded.

At Cargo, about fifty miles to the east, part of the Silurian series consists, in addition to breccias and tuffs, of trachytic and porphyritic keratophyres and quartz-keratophyres, and one specimen collected from the vicinity appears to be a variolitic spilite.

At Orange, too, probably among the Silurian rocks, are augite-andesites with spongy albite for phenocrysts and chloritized groundmass.

From Wellington district L. J. Jones (1918) has recorded tuffs and andesitic rocks, both volcanic and intrusive, intercalated with Silurian sediments, and these are likewise strongly albitized. Similar types, as well as albite-keratophyres, have been collected in the neighbourhood of Sofala and Trundle, and between Mudgee and Hargraves, and these were most probably extruded during the currency of the Upper Silurian sedimentation.

It would thus appear that much of the central part of the State west of the Main Divide was a petrological province with rather alkaline affinities during both Ordovician and Silurian periods.

Apart from these volcanic products of spilitic affinities which outcrop over a considerable area in the central parts of the State, there are extensive developments of acid tuffs of more normal petrological character in many places, which attain particular prominence along a belt stretching from Yass southward through the Federal Capital Territory (Mahony and Taylor, 1913) and along the valley of the Upper Murrumbidgee as far as Cooma. Some of these tuffs are fine, even-grained, bedded rocks, but other types are formed of crystals or grains of quartz, felspar and biotite or hornblende in a finer-grained matrix, and these may be fossiliferous and are occasionally found to be quite thickly studded with large angular fragments of volcanic and other rocks.

These tuffaceous rocks enshroud not a little mystery. In their brecciform and bedded phases their clastic nature is obvious, but those which are free from inclusions may resemble quartz-porphyries so closely as to deceive even the very elect. And even the brecciform types are found in the field behaving like thick sill-intrusions, being concordant in the main, but sending out tongues which transgress the bedding-planes of the associated sediments, sometimes tapering quickly, enclosing blocks of hardened country rock, and appearing to produce contact-metamorphism at their margins. The position is further complicated by the occasional occurrence of proper intrusive quartz-porphyries in close association with the tuffs. In thin section these rocks appear markedly fragmental, though some of them may exhibit characters approaching those of massive porphyritic rocks.

It seems not improbable that it is the existence of these anomalous types that has produced such positive and yet divergent views in regard to certain of the acid rocks of the Yass district (Shearsby, 1911; Mann, 1921; Sussmilch,

1923). Among these there are some which are undoubtedly quartz-porphyries or rhyolites, as observed in thin section, and others just as certainly clastic, and, as one cannot postulate cataclasis subsequently to consolidation, it would appear that the rocks in question, which do show intrusive phenomena in places, include "intrusive tuffs" as well as ordinary acid intrusives. At Jenolan, too, there is a rock, the so-called "green porphyrite" of Sussmilch and Stone (1915), which behaves in markedly intrusive fashion towards the associated Silurian strata, but in some portions contains abundant inclusions and may even enclose fossils, and in thin sections is seen to be a fragmental rock.

Pittman (1900) has recorded apparently intrusive fragmental rocks from the Ordovician strata of Lyndhurst goldfield, and Benson (1915) has described thin bands of tuff showing transgressive relations to Devonian radiolarian cherts of Tamworth. Both investigators find an explanation of their occurrence in a mechanical cause, which, however, will hardly afford a satisfactory solution of all the problems presented by these Silurian rocks.

The Silurian period was brought to an end by an epoch of diastrophism which, however, was less violent than that with which the Ordovician had closed. During its currency there was a certain amount of magmatic injection, but it must be admitted that our knowledge of plutonic intrusions of definitely closing Silurian age is but scanty. In Victoria, in the North Gippsland region, Howitt (1887) found quartz-diorites and granites intrusive into Silurian slates and Ordovician schists, and overlain by rocks of Lower Devonian age, so that the epoch of intrusion was fairly accurately indicated. These bathylithic masses have peripheral gneissic banding, which Howitt, with characteristic acuteness, recognized as a primary structure. What is without doubt the time-equivalent of these in New South Wales we find in an elongated intrusion which has been traced continuously from the town of Cooma northwards to the junction of Paddy's River and the Cotter, in the Federal Capital Territory, a distance exceeding sixty miles, while its greatest width must be about fifteen miles. It appears that the axes of Silurian and Ordovician folding were almost coincident in this region, and for the greater part of its length the igneous mass cuts through Ordovician schists and gneisses, so that only at the northern end, where it was examined by Mahony and Taylor (1913), are its relations with the Silurian strata obvious.

This intrusion provides what appears to be, for this country, a unique example of the close relationship that may exist between earth-stresses and magmatic differentiation. The main rock-type is of the nature of a quartz-mica-diorite, with biotite, hornblende, some well crystallized primary epidote, and an occasional crystal of allanite; it is somewhat gneissic in its main portions, becoming a regular primary gneiss along its eastern margin and wherever there are lenticular or tongue-like apophyses. Along this eastern edge there has been traced for a distance of more than forty miles an inconstant but often very prominent fringe of pink or white acid granite-gneiss, very evidently co-magmatic with the quartz-diorite, in fact bearing the same relation to it that Barrow (1893) found to hold between the pegmatite-fringes and the primary gneisses of the South-Eastern Highlands of Scotland. Towards the northern end of the mass, where no acid phase appears, the rock acquires potash-felspar and becomes a normal granite, affected to a greater or less extent by a cataclastic foliation. Dykes of

pegmatite and amphibolite, though present, are rare. The explanation that suggests itself is that the acid phase of the intrusion is the result of stress, directed from the west, acting on a magma not yet completely crystallized, the acid liquid residuum of magma being thereby squeezed outward and forward. The stress became much less severe towards the north, and was renewed after the complete consolidation of the rock.

This Upper Murrumbidgee intrusion is confidently assigned to closing Silurian times, as its general petrological characters and relations differentiate it from the massive granites of later intrusive epochs. The resemblance to the late-Silurian quartz-diorites of Northern Gippsland has already been pointed out.

Closely associated with this intrusion on its eastern side is a series of lenticular and sill-like intrusions of a very handsome granite-porphyry, with which are connected aplitic and pegmatitic phases and auriferous quartz-reefs. The gradation from granite-porphyry into granite near the northern extremity of the main intrusion is very striking.

Out further to the east at Michelago are two elongated and somewhat lens-like granite intrusions, the more easterly of them forming the highest portions of the Tindery Range. The other shows quite marked gneissic foliation in places, and one or both of the intrusions may be comagmatic with the Upper Murrumbidgee mass.

Further north, on the eastern shores of Lake George, is a series of schistose and slaty rocks, very probably forming an Ordovician inlier, and these are invaded by a strongly foliated granite-gneiss and by amphibolitic rocks which may both be late Silurian, though massive granites of later age also appear in the vicinity.

At Wheeo, about sixty miles north of Canberra, is a partly recrystallized gneissic granite, so strikingly similar to some phases of the Upper Murrumbidgee rock as to suggest its tentative correlation therewith.

Another granitic intrusion which may possibly date back to this late Silurian epoch of diastrophism is the great bathylith forming the major part of the Kosciusko plateau, but the time-relations of this are not accurately known. On the eastern side it is intrusive towards Upper Ordovician slates, and on top of the plateau it partially encloses a very large mass of phyllitic and slaty rocks which are comparable lithologically with Ordovician rocks elsewhere in the State, but at no point has a contact with younger sediments been observed.

The granite itself, which is usually of a fairly acid type, with biotite and a little muscovite, is in places massive, but for the most part is characterized by a superimposed gneissic foliation which may become strongly pronounced; this feature is well seen on Mt. Kosciusko itself, which is composed of an aplitic phase of the granite, containing muscovite and a little garnet. The granite is intersected, particularly near Pretty Point and along the Thredbo-Snowy divide, by dykes of hornblende-quartz-porphyrite and of a very beautiful hornblende-lamprophyre (spessartite) passing in places into a fine-grained diorite. Elsewhere patches of pyroxenite are found which have been apparently engulfed in and partially penetrated by the granite-magma.

A possible continuation of this bathylith is the extensive intrusion of granite and gneiss described by J. E. Carne (1895) from the Toolong and Bogong districts, some twenty to thirty miles north of Mt. Kosciusko. The granite bears a certain resemblance in some of its phases to that of Kosciusko, and a very similar hornblende-lamprophyre comes from the locality.

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It may be remarked here that it is in connexion with the Silurian diastrophism that we find the latest of the orogenic bathyliths in New South Wales, characterized by a generally concordant or lens-like disposition and by the prevalence in them of conspicuous gneissic banding and foliation, either primary or superimposed, indicating injection of the magma before the cessation of compressive movement. For the most part the bathyliths of succeeding intrusive epochs are of transgressive type, and without directive structures, and would be classed as "plateau" or "subsequent" bathyliths, though plainly related to orogenic epochs. Whether this difference between the pre-Silurian and post-Silurian intrusions is a function of the intensity of the orogeny or whether it is related indirectly to the thickness of sediments affected by folding we are hardly in a position to state.

Devonian.

We pass now to a consideration of the igneous activity of the Devonian Period. Rocks representative of the Lower, Middle and Upper Devonian Series are believed to outcrop in this State, and they have been the subject of a good deal of both special and incidental investigation. Our detailed knowledge of Devonian sedimentation along the western margin of New England we owe to the researches of Prof. W. N. Benson (1913), conducted in part during his tenure of a Macleay Fellowship. One of the most important and striking petrological results of Benson's work was to demonstrate the existence of a varied and extensive series of volcanic and intrusive rocks belonging to the spilitic suite, chiefly in the lower and middle portions of the Devonian sequence, and closely associated with radiolarian cherts. Spilitic rocks in their characteristic assocations were thus recognized for the first time in New South Wales, and probably in Australia. Benson considered most of the albite in the spilites to be of primary crystallization, but it is interesting to note that for those of the Tamworth area (1915) the possibility of a secondary (deuteric) origin for the albite was recognized.

Harper's (1909*b*) work about Yass and along the Murrumbidgee revealed the presence of a considerable thickness of acid lavas and tuffs at the base of the Middle Devonian limestones and shales, and these appear to be largely of keratophyric type. Further, similar flows and tuff-beds are intercalated among the Middle Devonian strata, the tuffs particularly being of great thickness. Harper originally (1907) regarded the basal series as submarine in character, but later he considered, and his conclusion is accepted by Sussmilch (1923), that they were probably terrestrial accumulations of Lower Devonian age. For this belief there appears to be no definite warrant, inasmuch as the rocks are resting on the marine Upper Silurian beds, are overlain by Middle Devonian strata, and, according to Harper's sections, are interbedded with shales.

It is interesting to note that the Devonian series described by Andrews (1901*a*) from Lobb's Hole, near Kiandra, includes keratophyric tuffs and breccias.

The Upper Devonian sea appears to have had a very wide extent indeed in New South Wales. It is usual to consider separately, on palaeontological grounds, the Lambian type of sedimentary series, in which quartzites, shales and conglomerates play an important part, and the Barraba mudstones of western New England. But though two separate faunal provinces may have existed, and though there is now a geographical separation between them, filled with Carboniferous and later rocks, there seems no valid reason for not regarding the Lambian

and the Barraba series as contemporaneously deposited, the one under very shallow-water conditions, the other farther from the coast. Indeed there is some reason to believe that Upper Devonian strata formerly occupied the areas now containing Carboniferous rocks in the Hunter and Upper Hunter Valleys, and even among the Lambian sediments there are evidences of an approach to something different from purely coastal conditions, in the shape of limestones about Capertee, Rylstone and Mudgee (Carne and Jones, 1919), and radiolarian cherts at Little Hartley.

Similar views of the essential geographical continuity of Upper Devonian sedimentation appear to be held by Benson (1922) and Sussmilch (1914), the latter considering that all the Devonian strata of the Great Serpentine Belt may really be contemporaneous with the Lambie beds.

Among the Lambian or shallow-water facies of these Upper Devonian strata there are some evidences of contemporaneous vulcanism. About Mt. Lambie, the type-district, the sediments include medium-grained acid albitic crystal-tuffs altered by contact with intrusive granite, and similar rocks occur at Yetholme (Andrews, 1916), where recrystallized quartz-felsites have also been found. The rocks at Hill End classed by Harper (1918) as Devonian (?) include a large proportion of tuffs, and specimens of these are remarkably similar to those from Mt. Lambie and Yetholme, and like them are albitic and recrystallized. It is quite probable that the soda-felspar, with which epidote is associated, is due to dissociation and recrystallization of an original slightly more basic plagioclase.

Around the Upper Macquarie Valley Harper (1909*a*) found among the Upper Devonian series extensive developments of volcanic products, augite-andesites, rhyolites and felsites, with agglomerates and volcanic ash, but no petrological details of these rocks are available.

At Yalwal, on the Lower Shoalhaven River, Andrews (1901*b*) found a great development of amygdaloidal basic lavas, alternating with flows of spherulitic rhyolite in subordinate amount. These latter are devitrified rocks still showing beautiful fluidal and perlitic structures and containing phenocrysts of albite; the basalts, though chloritized and in some cases converted into epidiorites, presumably by contact-metamorphism, show no traces of albitization, but a coarser-grained and evidently intrusive rock is a chloritized and carbonated albite-dolerite.

On the far south coast at Pambula and Eden, Carne (1896) found a rather bewildering medley of fragmental, lavaform and intrusive quartz-felsites or rhyolites. The rhyolite-flows are strongly fluidal and contain nodules up to 14 inches in diameter. The rocks are devitrified and in some cases contact-altered, and, so far as can be made out, some of them, at all events, are potash-rhyolites. Outcrops of amygdaloidal basalt are also found associated with the Upper Devonian strata in the neighbourhood of Eden, but their relations seem to be obscure. Some of them, at all events, are much chloritized and contain albite or oligoclase felspar.

It would appear that the Yalwal and Eden-Pambula volcanic rocks are correlable with the spherulitic rhyolites and basalts described by A. W. Howitt from the Iguana Creek beds at Mt. Wellington and Snowy Bluff in North Gippsland, Victoria (1876, 1877, 1878).

The Devonian Period was terminated by what Sussmilch (1914) has happily termed the Kanimbla epoch of diastrophism; this, though widespread in its

effects, was distinctly lacking in the intensity that had characterized the folding movements preceding it. But if the close of the Ordovician period saw the maximum Palaeozoic diastrophic disturbance it is probably not too much to say, that the close of the Devonian witnessed the greatest and the most important and spectacular display of intrusive igneous activity that is revealed in the whole of the geological record in our State. This expressed itself both in plutonic intrusions, chiefly of a granitic nature, and in hypabyssal injections of felsite, quartz-porphyry and quartz-porphyrite.

Of the geological age of many of the intrusions there is positive to reasonable proof, but in the case of many more decisive indications are lacking, though strong presumptive evidence exists. In Victoria there has been shown to be an unconformity between the Middle and Upper Devonian series, but in this State no contact has ever been recognized between them, except in the Great Serpentine Belt region, where they are conformable. It is certainly true that the Middle Devonian strata of the Murrumbidgee area near Yass have suffered much folding, but whether this took place at the close of Middle Devonian or at the close of Upper Devonian time it is not at present possible to say; the coincidence of the direction of strike of the Middle Devonian with that of the nearest Upper Devonian rocks would certainly suggest, but it by no means proves, posthumous folding for the former.

While, therefore, certain petrological and other similarities would tend to indicate contemporaneity for the intrusions grouped here as late-Devonian, it is necessary to take into account the possibility that some of them should really be referred to a closing Middle Devonian orogeny.

The late-Devonian folding affected to a greater or less extent all the sediments of the Lambian or shallow-water facies, away out as far west as Cobar and beyond, and as far east as the western boundary of the Permo-Carboniferous basin. It died out, however, in this direction, and Benson (1913) found the Barraba Series of the Great Serpentine Belt to be overlain by the Carboniferous beds without angular unconformity.

The rocks forming the intrusions are in general massive, without primary directive structures, and unaffected by shearing except of a very local character, and the bathyliths themselves appear to be on the whole transgressive, though in a broad sense the elongation of the masses may have been determined by the direction of the Devonian folding. The sill- or sheet-habit is developed to some extent, and marginal apophyses may be concordant, while about Bathurst and Yetholme the intrusions have been thought to possess somewhat of a laccolithic habit (Ross, 1894; Andrews, 1916). As a matter of fact, in the absence of systematic mapping and examination, the actual extent of many of the outcrops is not known, and in many instances it is not even certain whether the outcrops examined at different points are continuous or not. In regard to petrological details there is also much yet to be learnt, the only really thorough investigation so far carried out being that recently completed by one of our Macleay Fellows, Miss Ida A. Brown (1928), on the Moruya intrusion.

The evidence to hand, such as it is, would indicate that, whilst there may have been one vast magma-reservoir underlying the region affected by late-Devonian folding, independent differentiation in separate smaller basins must also have occurred, since the rock-series exhibited in the various bathylithic complexes are not by any means the same. As indicated below, the distribution

of the associated economic minerals suggests the possibility of some differentiation on a more regional scale.

It must be confessed that the compilation of a detailed list of Devonian intrusions bristles with difficulties, in the frequent absence of external or field-evidences of age. There are, however, certain guiding principles which have been utilized, arising from the following considerations:

1. Upper Devonian strata are known to have been laid down and to have been folded over an area extending beyond the River Darling on the west, but not so far east as the Great Serpentine Belt. Late-Devonian intrusions may be expected over this area.

2. It is fairly certain that neither the Carboniferous nor the Permo-Carboniferous geosyncline extended much further west than the present western boundary of the latter, and for a considerable width along this western margin there has been very little, if any, folding. Consequently any intrusions of Carboniferous or Permo-Carboniferous age are likely to have been confined to the area east of that line, so that no intrusions later than Upper Devonian may be expected west of it.

3. The evidence available from the known occurrences shows that both the late-Ordovician and the late-Silurian granites display a prominent development of gneissic structure, primary or superimposed or both, and that the intrusions have the more or less concordant habit of the sill or the orogenic bathylith. The known intrusions of Kanimbla age do not possess these features.

4. In association with the known late-Devonian intrusions, both hypabyssal and plutonic, a characteristic suite of economic minerals is found, including gold and ores of copper, silver, lead, zinc and tin, with compounds of tungsten, molybdenum, bismuth to a smaller degree, and a little antimony and arsenic. With the exception of gold, these are not found associated with the older Palaeozoic intrusions; they are, it is true, very characteristic of the late Palaeozoic granites of New England, but these are very strictly limited geographically. The map forming Plate v in the recently-published "Mineral Industry of New South Wales" is very suggestive in this connexion.

5. The rock-forming mineral sphene, and perhaps also hypersthene, may have some value for purposes of correlation. Neither of these has been detected as a primary mineral in the older Palaeozoic intrusions, and the first is quite prominent in some of the known Kanimbla plutonic rocks.

The generalization is put forward then, but tentatively, that within the area formerly covered by Upper Devonian sediments the plutonic and hypabyssal intrusions, of generally massive habit, may be referred to the Kanimbla orogeny, especially where they have in association some or all of the economic minerals specified above.

The validity of some of these principles is doubtless open to question, and further research may prove some of them to be badly founded, but they appear to be the best available in the present state of our knowledge.

Perhaps the most familiar of all the intrusions is that from which the Kanimbla epoch derived its name. It has been noted at Mt. Werong (Jones, 1924) and extends thence in a north-easterly direction to Kanimbla and Hartley. The roads from Hartley to Jenolan and Bathurst traverse it for many miles, and it extends over in a westerly direction through Sodwalls, Oberon and Tarana to the Bathurst Plains, while acid phases of it are found along the valley of the

Upper Macquarie. At Yetholme (Andrews, 1916, 1917) it has produced contact-deposits of molybdenite, and elsewhere gold and wolfram are its associates.

A certain amount of work has been done on various parts of the intrusion, but the complete story, when it comes to be written, will be full of fascination. The known differentiation-phases include aplites and pegmatites, porphyritic biotite-granite, hornblende-biotite-granite, quartz-monzonite, granodiorite, quartz-mica-diorite and more basic types. Contact-alteration of shales, fossiliferous quartzites and limestones has produced a rich variety of hornfelses.

Diorites and porphyritic granites outcrop between Capertee and Mudgee, and non-porphyritic types are found to the north of Mudgee and at Gulgong (where antimony lodes occur), Ulan in the Upper Goulburn Valley, and various other places along the western margin of the Permo-Carboniferous basin as far south as Wombeyan.

At Blayney Harper (1920) found sphene-bearing quartz-mica-diorite resembling the Hartley type intrusive into old Palaeozoic sediments, and Morrison (1916) noted molybdenite in an acid granite at Manildra, near Molong. Near Dubbo is the northern extremity of a mass of granite that appears to extend for a long distance to the south; at Yeoval in this belt, tungsten minerals have been found. A normal biotite-granite rich in orthoclase outcrops at Eugowra, extending westwards towards Forbes and Parkes; Morrison considers that this may be intrusive into Upper Devonian strata, and the petrological characters of the rock tend to support this view, but Andrews (1910) regards the intrusion as pre-Devonian. Possibly there are two intrusions of different ages concerned.

The biotite-granite of Cowra contains occasional garnets, evidently derived from some terrain through which the magma made its way, and this, with the belt of massive granite extending through Grenfell and Young, is probably referable to the Kanimbla epoch.

Small outcrops of granite have been noted near Trundle and Fifield, and granite and quartz-porphyry have been observed at Melrose (Jaquet, 1895) and elsewhere in the Condobolin district. Out to the north-west, at Nymagee and Nyngan, are granites believed to be Devonian.

At Wyalong (Watt, 1899) the principal intrusive rock is a quartz-mica-diorite, much crushed in places, which passes by transitional types into a beautiful hornblende-quartz-norite with fluxional fabric. These rocks have evidently been injected into a terrain consisting in part of ancient dolerites and allied rocks now completely recrystallized, but with traces of former textures, into granular hornblende-felspar rocks in whose formation contact-metamorphism appears to have played a part.

The very interesting intrusion at Ardlethan has been investigated by Harper (1912). There is some biotite-granite, but the principal type is a very acid one, in connexion with which pneumatolytic phenomena are abundant, the resulting minerals being tourmaline, topaz, mica and fluorspar, while the metallic ores include tinstone, and compounds of copper, bismuth, molybdenum, tungsten, lead and zinc. It would appear that the acid phase of the granite extends for about forty-five miles in a N.N.W. direction through Yalgogrin to Mulyan, and at least thirty miles to the S.E. of Ardlethan, and it may be more than a coincidence that ores of tin, tungsten and molybdenum, associated with acid granites, are found at intervals along a belt running about S.S.E. through Pulletop and Holbrook to Jingellic on the Murray (Carne, 1894; Harper, 1912).

Late Ordovician granite has been noted above as outcropping at Albury, but at the Hume Reservoir, about ten miles away, the granite, a massive, biotite-bearing type, is distinctly different in character, and on petrological grounds may be tentatively referred to the Kanimbla epoch.

At Adelong, according to Harper (1916), a quartz-felspar-porphyry accompanies the granite, which is partly a hornblende-biotite type, but with strong development of acid differentiates including greisen, aplite, and tourmalinic rocks. Intrusive into the granite and genetically connected with it by dioritic types is a mass of medium-grained olivine-norite passing into a finer-grained olivine-free marginal phase, the whole intrusion being characterized by beautiful fluxional and protoclastic structures. This Adelong granite may belong to the same mass as that of Tumbarumba to the south, and the porphyritic granite found by Harper (1912) in the country north of Yarrangobilly, with accompanying porphyry which is believed to extend for at least sixty miles to the north.

What is probably the eastern margin of the same granitic belt is well seen where it crosses the Murrumbidgee at Burrinjuck. The river here flows between walls of porphyrite and granite (Harper, 1909*b*) intrusive into Middle Devonian sediments, the granite including both normal types and the pink acid variety which was largely used in the construction of the dam.

The very interesting and rather intricate series of intrusives outcropping around Kiandra has been mapped by Andrews (1901*a*), and a study of some of the micro-sections of these strongly suggests the existence of a monzonitic series with distinctly calcic affinities. The "syenitic diorite" of Andrews's report is a somewhat altered plutonic rock with fluxional fabric, which has possibly too little orthoclase to permit of its being grouped with the monzonites; then there are the interesting hypersthene-bearing quartz-monzonites and monzonite-porphyries, whose pyroxene contains remnants of olivine (Browne and Greig, 1922), mica-diorites grading into more basic types with but little felspar, and finer-grained monzonitic rocks passing into hornblende-lamprophyre. A common feature of practically the whole series is the association of pyroxene, hornblende and biotite, the hornblende being very evidently a primary crystallization but formed partly at the expense of the pyroxene, and the biotite being moulded on the plagioclase.

About Kiandra there is also a biotite-hornblende-granite with sphene, closely resembling some of the Bathurst-Hartley types, but whether this is genetically related to the monzonitic series is not clear. Apparently associated with this granite are dykes of quartz-felspar-porphyry.

Passing to the south-east we note the Berridale granite, an intrusion which has a considerable extension northward towards Adaminaby and southward through Dalgety; where examined between Berridale and Cooma it is of tonalitic character and is quite massive and distinctly transgressive towards the Upper Ordovician slates (Browne, 1914). Probably satellitic to this intrusion is a small boss of monzonitic quartz-syenite and syenite-porphyry outcropping about six miles south of Cooma, and forming one of the few known occurrences of syenite in the State; from this dykes of felspar-porphyry and bostonitic trachyte radiate, one of which has been traced beyond Cooma.

The Late Devonian age of these rocks is inferred from their petrological and structural characters, which contrast sharply with those of the late-Ordovician and late-Silurian intrusions at Cooma. To the same epoch are referred the very similar granodiorite of Gunning and the quartz-diorite of Binalong (Carne, 1894). The hypersthene-bearing granodiorite of Tallong has been mapped and described

by Woolnough (1909); it is closely associated with quartz-porphyrite and with the Marulan granite, to both of which it is evidently related.

South from Goulburn massive acid granites occur near Mount Fairy, and at Boro, south-east of Tarago, where tinstone has been mined (Harper, 1915).

The hornblende-biotite-granite of Braidwood and Major's Creek is of interest for the occurrence in it of free gold visible to the naked eye; quartz-porphyry is an associate (Anderson, 1892).

The erosion of the Shoalhaven tributaries at Yalwal has laid bare an interesting series of Upper Devonian rocks (Andrews, 1901*b*), which have been injected by acid granite and porphyritic microgranite or aplite. Passing over some small granite inliers with tin and copper ores among the Permo-Carboniferous strata about Wandandian and Conjola, we come to the intrusion at Moruya, on the South Coast (Brown, 1928). This proves to be an igneous complex of typically calcic character, comparable chemically with that of Garabal Hill, Scotland, and composed of petrological types ranging from ultra-acid aplite to very basic hornblende-gabbro. The intrusion appears to have a sheet-like disposition and may link up with that at Araluen, about thirty miles to the north-west.

Further south along the coast may be noted as of probable Kanimbla age the quartz-diorite of Cobargo, the granite and quartz-mica-diorite of Brogo and the porphyritic granite and sphene-bearing granodiorite of the Bega district. The plutonic complex of which these are members is of great extent and considerable economic importance; it extends westward almost to Nimmitabel, south-west to the neighbourhood of Bombala and south through Wolumla and Wyndham to the Victorian border east of Nungatta River, with many textural, chemical and mineralogical variations. Gold, as well as ores of tungsten, molybdenum and bismuth, have been found at various points in association with the intrusion (Carne, 1897*a*).

From the point of view of petrogenesis many of these late Devonian rocks are of considerable interest as affording evidence of the operation of N. L. Bowen's (1922) "reaction-principle". Attention has been drawn above to the existence of "reaction-series" in the Kiandra rocks, and these have also been found in the Moruya complex. Other illustrations of the principle are to be found in the Wyalong norite, the Adelong diorite, the Tallong granodiorite and the Hartley quartz-diorite.

It appears as though there may be much of interest and importance in a study of the geographical distribution of the various economic minerals through the area covered by the Kanimbla intrusions. There seems to be, for instance, a tendency for the concentration of tinstone along the western or south-western margin of the area, but whether this is real or only apparent it is at present not possible to say. Another apparent tendency is for the occurrence of sphene in many of the granites and quartz-diorites of the more easterly belts, such as those of the South Coast and those along the western margin of the Permo-Carboniferous basin.

The felsites, quartz-porphyries and quartz-porphyrites which were very abundantly injected during the Kanimbla orogeny are without doubt co-magmatic with the granites, with which indeed some of them are closely associated, though many are quite independent. They have perhaps a tendency to occur as dykes, sills, and sheet-like intrusions, with a trend determined largely by that of the older rocks through which they have been forced.

The time-relations of hypabyssal and plutonic intrusions are not always clear. Carne (1896) has noted that the auriferous quartz-felsites of the far South Coast, as at Eden and Pambula, and possibly those of Wagonga and Tathra, farther north, while intrusive into the Upper Devonian sediments, are themselves invaded by the granite, and they actually show evidence of contact-metamorphism, as do also the felsites of Hartley. It would almost appear, indeed, as if the hypabyssal intrusions might be divided into two groups, the felsites, antedating the granitic intrusions, and the porphyries and porphyrites which were sometimes injected later than the granite, but which are frequently of indeterminate age-relationship towards it.

Petrologically there is a considerable variety in these rocks. The felsites are frequently devoid of any phenocrysts save felspar and perhaps quartz, but the porphyries and porphyrites may have, in addition, biotite or hornblende or both. Hypersthene has been detected in the so-called "Yass porphyry", in the porphyrite from Tallong and Marulan, and in a quartz-porphyrite outcropping at the Wollondilly River on the road to Wombeyan (Card, 1907). Some of these rocks are remarkably fresh and free from alteration, but others, especially the porphyrites, are much changed, with the production of much epidote and chlorite. Occasionally the principal felspar is albite and the rocks should be placed with the quartz-keratophyres, but it seems very probable that these rocks are really albitized quartz-porphyrites.

Among the hypabyssal intrusions not already referred to are the quartz-felsites noted in the neighbourhood of Tarana (Carne, 1899) and Cargo, and at places like Rylstone, Capertee and elsewhere along the margin of the Western Coalfield (Carne, 1908). The quartz-porphyry and quartz-felsite sills of Jenolan have been described by Sussmilch and Stone (1915) and are tentatively classed as Devonian. The silver-lead deposits of Yerranderie and Mt. Werong (Carne, 1899) are in similar rocks, the former probably part of a belt extending south beyond the Wombeyan Caves.

As far west as the Cobar district and Mount Hope quartz-porphyries have been noted (Andrews, 1913), which are very similar to Kanimbla porphyries in other parts of the State. A biotite-quartz-porphyry from Canowindra appears to have suffered slight alteration, possibly from a neighbouring granite-intrusion, and a typical Devonian quartz-porphyry comes from near Tumbarumba (Carne, 1894). At Kangiara, about 15 miles north of Bowning, a very similar rock was found, and this may form part of the belt which includes the Yass sills, already referred to. The Yass porphyry of Harper (1909*b*) appears to be a great interformational sheet which has made its way along the junction between the Upper Silurian rocks and the overlying Devonian lavas and tuffs in the Yass district.

Around Goulburn and Marulan, and to the north towards Longreach, the quartz-porphyry is associated with the Marulan granite, while, possibly as a southward continuation of the Yass intrusions, a great series of sill-like masses of quartz-porphyries, quartz-porphyrites and felsites forms isolated hills and meridional ridges in the Federal Capital Territory (Mahony and Taylor, 1913), and up the Murrumbidgee Valley, passing a few miles to the east of Cooma. It was probably in connexion with these felsites that the copper, lead and other mineral-deposits of Bushy Hill at Cooma were introduced.

The occurrences mentioned above probably form but a small proportion of the total number of hypabyssal intrusions of Kanimbla age, which indeed appear almost to have rivalled the granites in volume.

With the exception of a few inliers of granite at Yalwal and further south the Kanimbla intrusions are cut off to the east sharply by the western boundary of the Permo-Carboniferous basin, running a little west of north. Nevertheless there is evidence that injection took place as far over as the Hunter Valley, for the granodiorites which faulting and erosion have revealed at Pokolbin (David, 1907) and Gosforth (Browne, 1926), and which are now overlain by Kuttung sediments and lavas, are massive sphene-bearing rocks of typical Kanimbla characteristics. These probably represent remnants of the igneous cores of late-Devonian mountains which suffered denudation in Lower Carboniferous times.

The Kuttung conglomerates of the Lower Hunter Valley are composed in a large measure of pebbles of aplite, granite and quartz-porphyry, while quartz-porphyry, with a little diorite and hornblende-gabbro, occurs as pebbles in the Permo-Carboniferous strata as high as the Upper Marine Series; these must surely have been derived from the erosion of highlands of late-Devonian granite and porphyry formerly lying to the south and west. It is of interest to note that Rev. W. B. Clarke recognized the resemblances between these pebbles and the exposed Devonian porphyries of the South Coast (1860).

Benson (1913) found the Rocky Creek (Kuttung) conglomerates west of the Great Serpentine Belt to consist largely of granites, aplites, quartz-porphyries, quartz-porphyrites and rhyolites, and these are so similar to known Devonian types as to suggest their probable derivation from an Upper Devonian terrain consisting of rhyolites like those of Yalwal, and intrusive granites and hypabyssal rocks.

It will be convenient at this point to make some mention of the serpentines outcropping in the area occupied by the Kanimbla intrusions. The principal outcrop is that which, according to the State Geological Map, starts about ten miles north of Yarrangobilly and, striking about N.N.W. in a narrow belt, extends for more than fifty miles to a point about ten miles N.N.E. of Coolac. Harper (1912) observed it at its southern extremity and on a continuation of its strike the same worker (1914) noted serpentine at Cullinga, near Cootamundra. Jaquet (1896) had previously investigated a somewhat similar occurrence at Berthong and Wallendbeen, so that the total length of the line along which serpentine has been found is of the order of ninety miles. Other smaller outcrops occur about Gundagai, to the west of the main line (Carne, 1895).

In association with the serpentines at various points fresh and massive ultrabasic rocks have been discovered, diallagite and hornblendite at Berthong, diopside-bearing hornblendite at Cullinga and diallagite and enstatite-peridotite at Gundagai (Card, 1896), the latter, as I am informed by Mr. H. G. Raggatt, B.Sc., occurring in fair abundance. The Cullinga serpentine shows good mesh-structure and contains a little diopside, while that of Berthong is devoid of mesh-structure, but is sometimes antigoritic and shows traces of bastite.

It would appear that a series of ultrabasic rocks representing both the peridotite and the perknite groups was injected, possibly, as in the Great Serpentine Belt, along a plane of overthrust, and that the serpentine has been derived from rocks of both groups. Some local shearing is in evidence, but as it

affects both hornblendites and serpentines it was evidently not a necessary factor in the genesis of the latter.

Nothing appears to be known as to the geological age of these rocks. They are associated with unfossiliferous slaty rocks, evidently of great age and surmised to be Silurian. Harper found granite-porphyry intrusive into the Cullinga serpentines, while Jaquet's map shows the Berthong rocks surrounded by a somewhat crushed granite which he considers older than the serpentine.

In the absence of satisfactory field-evidence any attempt at fixing the age of the rocks is little more than a guess, but in view of the existence of fresh and undeformed ultrabasic rocks associated with the serpentine it would appear that they had not suffered much from diastrophism since their injection, and perhaps, therefore, they might be tentatively assigned to a Devonian intrusive epoch, either late Middle Devonian or Kanimbla. In this connexion the north-west trend of the belt, in general parallelism with the prevailing strike of the Devonian rocks over to the east, may be significant.

Serpentines have been reported from Lucknow (Pittman, 1900) apparently intrusive into andesitic rocks which are possibly of Silurian age. Nothing definite is known as to the age of the ultrabasic rocks.

Carboniferous and Permo-Carboniferous.[1]

The wonderful display of volcanic activity which characterized the Carboniferous Period has been made familiar to us by the labours of a number of workers, including a former Macleay Fellow, Mr. G. D. Osborne, B.Sc., and the details of it are admirably summarized in Mr. Sussmilch's address.[2]

Lava-flows and showers of fragmental material occurred during the Burindi marine sedimentation, but the climax of eruptive activity was reached during the succeeding Kuttung epoch. It has proved difficult to find any definite rule resuming the general order of succession of extrusion of the volcanic products. There are some signs of an order of increasing acidity repeated in two or three cycles, the earlier flows of hornblende- and pyroxene-andesites being followed by more acid types, toscanites, dellenites, rhyolites and rhyolitic tuffs; but if we consider the vulcanicity as extending into the Permo-Carboniferous Period, we find the succession continued in basalts and acid tuffs, with no reversion to the andesitic type. This would suggest the operation of Iddings's "law of increasing divergence".

Probably nowhere in this State is there to be seen a more impressive object-lesson in the part which explosive eruptions may play in a volcanic sequence than in the areas occupied by the Kuttung rocks; an accurate estimate is of course out of the question, but it is safe to say that the total volume of frag-

[1] The use of this term has been criticised as being out-of-date and misleading. But until a majority of stratigraphers and palaeontologists, native and foreign, are finally agreed among themselves as to which of our Late Palaeozoic rocks are really Carboniferous and which truly Permian, it is surely preferable, for the avoiding of confusion, to retain the name Permo-Carboniferous as a system-designation, to include all the strata between the top of the Kuttung series and the base of the Trias.

[2] The following are the principal references for the Kuttung vulcanism: Benson, 1913 (Great Serpentine Belt); Benson, 1920, and Browne, 1920 (Currabubula); Browne and Walkom, 1911 (Pokolbin); Jaquet, 1901; Sussmilch and David, 1919 (Seaham, Paterson, etc.); Osborne, 1922, 1925 (Seaham, Paterson, etc.); Browne and White, 1926 (Allandale); Browne, 1926 (Gosforth); Sussmilch *et al.*, 1928 (Port Stephens).

mental material ejected from the Kuttung volcanoes far exceeds that of the lava, and practically all of it is rhyolitic.

Though a good deal of work has already been done in connexion with the Kuttung vulcanicity much still remains to be learnt. We do not yet know, for example, and only detailed field-work can tell us, why it is that in the southern areas the andesitic magma made its way to the surface, whereas in more northern parts, as at Currabubula, sill-intrusions and dykes appear to be the rule, though further to the north-west andesite-flows are interbedded with the Kuttung conglomerates.

Another matter that has yet to be cleared up is the relationship of the glassy and stony types of andesite. Some lines of evidence tend to show that they are separate and distinct phases, while on other grounds it would appear that devitrification or some such process has been responsible for the conversion of glassy into stony types.

Another interesting inquiry is concerned with the reason why the trachytic and pilotaxitic types of intermediate rock are so common at places like Currabubula, Pokolbin and Allandale, whereas they are absent elsewhere, except as occasional fragments in some of the tuffs.

Throughout their entire extent of about two hundred miles, the Kuttung igneous rocks exhibit remarkable constancy of mineralogical character. In the andesites, hypersthene, augite and hornblende form the ferro-magnesian constituents, while biotite is more characteristic of the acid types. Another remarkable feature of the rocks, wherever they have been studied, is the very prevalent, though selective, deuteric alteration, which has incidentally rendered very difficult the complete elucidation of the petrological relationships of the various rock-types. Only the dominantly glassy lavas have entirely escaped, and there is some evidence that potash as well as soda was introduced by the magmatic solutions by which the rocks were permeated.

Albitization is a phenomenon which has been observed mostly in the case of submarine lavas or in intrusions, and its prevalence among these terrestrial rocks is somewhat unexpected. A feature of the alteration of the Kuttung rocks which may have some significance is that practically no zeolites have been formed, and that carbonates are almost entirely absent.

Apart from its interest as the first series of indubitably terrestrial volcanic products to be preserved in our geological record, the Kuttung sequence is crammed full of absorbing problems which will serve to engage the interest of our petrologists for many years to come.

The Kuttung lavas and tuffs were poured out over a portion of the land-surface that was steadily sinking, and eventually terrestrial gave way to marine conditions in the Lower Hunter Valley, the transgression gradually spreading to north, south and west. But there was apparently no intermission of volcanic activity, and right through the Permo-Carboniferous system from base to top we have quite a considerable record of contemporaneous outpourings. The magnitude of this is liable to be underestimated owing to the ejected matter being largely fragmental and mixed up with ordinary mechanical sediment.

In the Lower Hunter Valley, as Sir Edgeworth David's (1907) investigations have shown, there are extensive flows of basalt and olivine-basalt on at least two different horizons in the Lower Marine Series. These were outpoured in shallow water, and though not altogether comparable with the spilites they give evidence

of much magmatic alteration, by which the olivine has been changed to iddingsite, and the basic felspars have been albitized or zeolitized, while there has been much deposition of zeolites, chlorite, calcite and chalcedony. The incidence of the solutions has not been universal, for fresh, unaltered basalts are found with the others.

Evidence has been found to the east of Raymond Terrace suggesting strongly that these basaltic eruptions were continued into Greta Coal-Measure times, and at Jerry's Plains Mr. H. G. Raggatt has discovered, interbedded with the Upper Coal-Measures, amygdaloidal basalts with analcite-lined vesicles.

In more northern areas, as about Muswellbrook, Scone and Wingen, the Lower Marine basalts are well in evidence, and at Temi, near Murrurundi, analcite-bearing basic lavas are interbedded with strata at least as young as Upper Marine.

The relationships of the Werrie basalts of Werris Creek and Currabubula to these Permo-Carboniferous flows is still in doubt. Benson is inclined to regard the former as of Upper Kuttung age, and only detailed field-work will reveal the true state of affairs.

Acid magma is represented by tuffs and tuffaceous sediments varied in places by breccias, flows being rare. The fragmental material attains in places considerable thickness, as about Harper's Hill, and to the south-west of Paterson practically the whole of the Lower Marine Series is volcanic, consisting of felsitic tuff and breccia with a thick basalt-flow near the top. A fine-grained buff-coloured tuff is very characteristic of the Greta Coal-Measures and has been observed over a wide area, from near Raymond Terrace as far as Muswellbrook and Wingen. At Muswellbrook there must be a few hundred feet of felsitic tuff and breccia included in the Greta Coal-Measures.

The outlier of Permo-Carboniferous rocks at Temi, near Murrurundi (Carne, 1903) resting on Kuttung glacial beds, contains a good deal of volcanic material. In addition to the analcite-bearing basic lavas which lie both above and below the kerosene-shales there are fine white tuffs immediately overlying the seams, and a considerable thickness of felsite-breccia at a somewhat higher horizon, while an arkosic-looking tuff containing *Glossopteris* separates the kerosene-shales and the Kuttung conglomerates in places. The age of the freshwater beds has not been definitely fixed; Carne considers they may belong to the Newcastle Series, but a Greta age cannot be ruled out as a possibility.

In some parts of the Lower Hunter Valley tuffs persist through the Upper Marine Series, and tuffaceous mudstones occur in the western areas, as at Hartley, and in the south-west, as at Bundanoon and Tallong.

In the Newcastle Coal-Measures acid tuffs have been recognized, and the cherts which outcrop on various horizons in the Newcastle area have themselves been regarded as consisting of exceedingly fine volcanic dust.

The remarkable series of trachyandesites, trachybasalts and associated tuffs which were erupted during Upper Marine and Upper Coal-Measure times and outcrop now along a narrow strip of the South Coast between Wollongong and Nowra, have been closely investigated by Jaquet, Harper, Card and the chemists of the Geological Survey (Harper *et al.*, 1915). Petrologically they are entirely different from anything else in the way of volcanic rocks hitherto discovered in the State or even in the Continent; and they are of further interest in that erosion of the lower stratigraphical units has revealed about Milton laccoliths and sills of monzonite and monzonite-porphyry representing minor intrusions from the same

magma-reservoir (Harper *et al.*, 1915; Brown, 1925). In these latitic lavas, and to some extent in the Milton intrusions as well, deuteric processes involving the introduction of soda, potash and carbonic acid have been at work (Browne and White, 1928).

We now turn our attention to New England, to some extent a geological *terra incognita*, a land as yet of many stratigraphical mysteries, and an area in which orogenic forces continued to be active long after other parts of the State had attained comparative stability.

Of Kuttung vulcanism as of Kuttung sedimentation in New England we have no sure knowledge. Around Drake Andrews (1908) noted a great development of rhyolitic flows, breccias and agglomerates, overlain by a newer series of multi-hued lavas, tuffs and breccias which he considered andesitic. With these he would group tentatively (1905, 1907) a series of grey felspar-porphyries at Tenterfield, Wallangarra and Ballandean (Qld.), and a series of acid porphyries or spherulitic rhyolites, with tuff and breccia, such as are found at Mts. Spiriby and Bajimba, Glen Innes, Inverell, Emmaville and elsewhere.

The exact age of these rocks appears to be a matter of doubt. They are interbedded with fossiliferous strata at Drake, and Andrews originally assigned them all to the Permo-Carboniferous Lower Marine epoch, but, according to Sussmilch (1923), subsequently relegated the older series to the Kuttung epoch.

The nearest known Late Palaeozoic volcanic rocks are the rhyolites, andesites and basalts, with associated tuffs and breccias, of the Silverwood-Lucky Valley area in Queensland, about fifty miles north-west of Drake. Richards and Bryan (1923, 1924) are very emphatic as to these rocks being interbedded with Upper Marine sediments, and in spite of propinquity and some lithological similarity are reluctant to correlate them with the Drake rocks on the score of the difference in stratigraphical position. But according to Andrews's Drake report many fossils of Upper Marine as well as many of Lower Marine facies were collected in the vicinity of Drake, particularly the coral *Trachypora* which is exclusively Upper Marine in the Hunter Valley, and it appears not impossible that the lavas should really belong to the higher horizon.

Microscopic examination of a number of the Drake rocks shows that, apart from the rhyolites, practically all of them are soda-trachytes or keratophyres with a few potash-trachytes, from which in all probability the others have been derived; the tuffs and breccias are composed largely of fragments of trachytic keratophyre. A few pilotaxitic andesites are in the collection, some apparently altered by a neighbouring granite-intrusion, and a few dolerites, in part recrystallized. So far as can be ascertained there are no differences between the rocks of the older and newer series, except for the absence of rhyolites among the latter, and it is reasonable to conclude that they should all be grouped in the same volcanic series.

Petrologically the nearest analogues in New South Wales to the Drake rocks are those forming the dykes and sills through the Kuttung series at Currabubula, and these are considered by Benson to be of Upper Kuttung age.

In the absence of more conclusive evidence it appears most natural to correlate the Drake rocks with the Silverwood-Lucky Valley Upper Marine flows, but it is by no means improbable that Andrews's "grey felspar-porphyries" are Kuttung lavas.

In the Kuttung-Permo-Carboniferous succession we have preserved to us an unusually complete record of geological events extending over a very long interval of time and resulting in the accumulation of strata exceeding 20,000 feet in maximum thickness. Of tectonic episodes, in addition to minor fluctuations, there are represented major vertical movements producing transgressions and retreats of the sea, as well as a folding movement which affected a considerable portion of the area undergoing sedimentation, while volcanic outbursts, terrestrial or submarine, were almost continuously occurring in one place or another, influenced no doubt by the unstable conditions and the ceaseless oscillations of the uneasy lithosphere. Here, therefore, if anywhere in our geological record, we should have a splendid field for studying the interplay of tectonic and volcanic forces, and for tracing in detail the relationships which connect the erupted rocks with the conditions that begot them.

Late-Palaeozoic Orogeny.

Before proceeding to consider the late-Palaeozoic plutonic intrusions it will be necessary for us to discuss the question of the orogenic epochs with which they were associated, for considerable uncertainty surrounds the chronology of the series of tectonic episodes which took place between the Kanimbla epoch and the close of the Permo-Carboniferous period.

It has been customary to assume an epoch of folding at the close of the Kuttung sedimentation, but on close examination this assumption appears to rest upon an insecure foundation. It is true that dipping Greta Coal-Measures at Ashford, near the Queensland border, lie with a violent unconformity upon what appear to be strata of Carboniferous age (Pittman, 1896; David, 1907), and that Benson has found Carboniferous rocks involved in the overthrust of the Great Serpentine Belt while Permo-Carboniferous strata are unaffected. But it should be pointed out that the Carboniferous rocks at Ashford are marine, and therefore probably of Burindi age, and that along the Great Serpentine Belt the only faulted Carboniferous strata are those of the Burindi series, while the unfaulted Permo-Carboniferous rocks belong to the Upper Marine and Upper Coal-Measure Series.

It would appear, then, that all that can be said about the date of this diastrophism is that it lies some time between late-Burindi and Greta times.

Now if we turn to the Lower Hunter Valley we find the Lower Marine Permo-Carboniferous rocks resting upon the freshwater Kuttung strata without any angular unconformity that can be detected (Browne, 1926), though there is evidence of overlapping and non-sequence, such as might be caused by sagging and a gradual encroachment of the Permo-Carboniferous sea, and in no case, to the best of my knowledge, has an angular unconformity such as might be due to late Kuttung orogeny been noted where Kuttung and Permo-Carboniferous rocks have been observed in contact.

Again, although both to the west of the Great Serpentine Belt and in the Lower Hunter District there is no angular unconformity between the folded Kuttung and Burindi beds, the base of the former or freshwater division is marked by heavy conglomerates, such as we do not find in the lowest Permo-Carboniferous beds; and in the New England area, where the Burindi beds were strongly folded and bevelled off before the Greta Coal-Measure epoch, no traces of Kuttung sedimentation have hitherto been discovered.

All these circumstances would seem to point to a strong crustal deformation in late-Burindi times, as indeed was contended by Sir Edgeworth David in his Presidential Address to this Society in 1893.

Another late-Palaeozoic diastrophism of which we have proof in the Lower Hunter Valley is that which was responsible for the folding of the Kuttung and most of the Permo-Carboniferous strata, and which, as Sir Edgeworth David has demonstrated (1907), had its commencement at the close of the Upper Marine epoch.

In the light of what has been said above it is perhaps permissible to put forward the following brief and tentative explanation of the facts.

At the close of Burindi times intense folding in New England, due to or accompanied by a thrusting movement from about E.N.E., put a period to the marine sedimentation. The compression was relieved to the west by a series of overthrusts along what is now the Great Serpentine Belt, which saved the strata to the west from being deformed. Along the major thrust-plane ultrabasic magma was injected, but of concomitant abyssal intrusion in the heart of New England we have no record. So far as this State is concerned the orogeny was localized in New England, and to the west and south it appeared only in movements of vertical uplift which among other things caused the retreat of the Burindi sea. The New England of Kuttung times was a plateau-area and underwent denudation, but some time during the Permo-Carboniferous period, possibly in the Lower Marine epoch, the sea began to encroach from the east, and the former plateau became once more part of a large area of depression, sedimentation and volcanic activity. In late Upper Marine times there was a revival of the orogeny; in New England the folding was so intense as to convert the soft shales into something like slates, but to the west, south-west and south it was less pronounced, and in the outlying parts of the geosyncline it manifested itself only as a gentle uplift, sufficient to drain the Upper Marine sea and permit of the deposition of the Upper Coal-Measures.

Igneous intrusion, represented by the New England granitic suite, was mostly confined to the more severely folded tracts, but came probably as far south as the Barrington Tops, and its most southerly effects are seen in the goldfields about the Barrington plateau and the deposit of stibnite among Burindi shales at Antimony Hill on the Allyn River.

Late-Palaeozoic Intrusions.

But little is known of the igneous history of New England prior to Permo-Carboniferous times. Doubtless among the schists and other ancient rocks of which it is in part composed there are igneous intrusions, but, if so, nothing very definite is known about them.

The first igneous episode of late Palaeozoic times of which we have knowledge is the intrusion of the great series of ultrabasic rocks now forming the Great Serpentine Belt, the subject of Benson's classic researches (1913, 1915, 1917). These appear to have been injected mainly along a steeply-dipping overthrust fault-plane and the line of intrusion has been estimated to extend almost 250 miles (Benson, 1926) along the western and southern flanks of the New England plateau. The original rocks were peridotites (harzburgites mostly), with a little pyroxenite, and these have been almost completely altered to serpentine, massive and schistose. Injected through them are gabbroid rocks, eucrite, olivine-gabbro,

now more or less altered, and garnet-gabbro, while dolerites of more than one type appear, though these may be of later age. It is probable that the serpentines of Port Macquarie (Carne, 1897*b*) and perhaps those of Gordonbrook (David, 1891) and Solferino, at the head of the Clarence River, are coeval with those of the Great Serpentine Belt.

The granitic complex forming a great and important part of New England has been examined at different points by a number of workers, but the great task of correlating the various units and giving a comprehensive account of the whole intrusive epoch has fallen to E. C. Andrews (1905, 1907), with the collaboration of G. W. Card and J. C. Mingaye in the petrological and chemical part of the work.

According to Andrews the first episode was the intrusion of the so-called "blue granite", which is actually a magnificent quartz-porphyrite, containing augite, hornblende and biotite among its phenocrysts, set in a fine-grained to microcrystalline groundmass; this is regarded as a sill-like or laccolithic mass of great size and with a thickness of at least 800 feet. The second series of intrusions is composed of a quartz-monzonite or granodiorite, with phenocrysts of orthoclase, and megascopic crystals of sphene, a very striking and beautiful rock. This outcrops throughout northern New England, and a somewhat similar type is found at Kootingal and Walcha Road, about 150 miles to the south.

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The next important series of intrusions consisted of coarse acid granites, with which are associated deposits of ores of tin, molybdenum, bismuth, tungsten and antimony, introduced during what Andrews calls the Euritic Period, a late phase of the acid granites which also gave rise to aplites. Some dykes of quartz-porphyry and spherulitic granophyre appear to have followed, and the intrusive cycle was closed by the eruption of a series of lamprophyres containing biotite, hornblende and augite.

The account given by Andrews makes it evident that these New England intrusions form a great composite bathylith or plutonic complex of regional dimensions and of surpassing interest, illustrating many phases of magma-differentiation and demonstrating in convincing fashion the magmatic origin of the associated ore-deposits.

There is a group of intrusions of granitic and dioritic type, developed particularly about Hillgrove (Andrews, 1900), which Andrews places tentatively within the Permo-Carboniferous Series described above. The rocks, however, have all been very much sheared, and it would appear more probable that they belong to a much earlier epoch of intrusion. Mr. G. D. Osborne, who has recently travelled over some of these rocks, informs me that they recall some of the highly-sheared older Palaeozoic rocks about Cooma.

Granites, quartz-felsites and porphyrites invade the Permo-Carboniferous and older strata at various points on the eastern parts of the New England plateau and along the coast; these do not appear to have been specially investigated.

What was possibly the final intrusive event of the Permo-Carboniferous period is the subject of a preliminary note by Miss Ida A. Brown, B.Sc., to be presented this evening. This was the injection, at Mt. Dromedary, on the South Coast, of a monzonitic magma with alkaline differentiates including shonkinite and nepheline-bearing types. The occurrence is noteworthy among other reasons because it is the only alkaline plutonic intrusion of probable pre-Triassic age of

which we have any knowledge, and the results of the detailed investigation of the mass should be of the greatest interest.

A comparison of the general characteristics of the plutonic intrusions belonging to the Kanimbla and late Permo-Carboniferous diastrophic epochs provides some interesting petrological parallels, inasmuch as both series contain dioritic types and porphyritic granites with sphene (a mineral notably absent from the pre-Devonian intrusives), while acid differentiates on a large scale are common in both series, accompanied by exactly similar suites of economic minerals.

It may well be that the same magma once underlay the whole region comprising practically the whole of New South Wales except the far western parts, and that while conditions favourable to its eruption existed in late-Devonian times over most of the State, in the New England portion these were not realized until much later.

This same possibility is suggested by Miss Brown (1928) who envisages "the active front of invasion", advancing *en échelon*, as it were, from Victoria through New South Wales into south-eastern Queensland. Perhaps the conception might even be extended to cover Tasmania, where there are many granite bathyliths, with related gabbros and ultrabasic rocks, believed to be of Devonian age, whose metallic concomitants are very similar to those characteristic of the late-Devonian and Permo-Carboniferous magmas of New South Wales.

Intrusions incertae aetatis.

The foregoing account has been somewhat in the nature of a progress report, from which there are many omissions, partly because of the incompleteness of our knowledge of the rocks of the State, but partly also because there are many known intrusions of a minor character whose antecedents can never be ascertained from field-evidence, and whose internal characteristics reveal nothing that is very distinctive. Chief among these are the dykes and plugs of dolerite and quartz-dolerite which intersect the Palaeozoic strata at various places. Some of these are so altered, being now really epidiorites, that they must be very ancient, others are so fresh that they resemble closely the rocks of certain intrusions of known post-Palaeozoic age, and some or all may quite possibly represent feeders either to submarine eruptions or else to terrestrial basalt-flows, now obliterated, which were outpoured during the continental periods succeeding the folding epochs.

Into the same category fall the interesting basic and ultrabasic plutonic intrusions which must underlie much of the eastern part of the State, and whose existence we infer from the numerous fragments occurring as inclusions in the Tertiary dykes and volcanic necks (Sussmilch, 1905; Harper, 1915; Benson, 1910; Osborne, 1920).

Summary and Conclusions.

The late-Palaeozoic folding represents the last orogenic disturbance of any magnitude experienced within the borders of the State, and it marks the last epoch, so far as we know, of bathylithic injection; at this point, therefore, our review of igneous activity may fittingly be brought to a close.

It may not, however, be out of place to attempt to draw some general conclusions from the detailed account which has been given. The accompanying table (pp. xxxvi-xxxvii) contains a condensed summary of the eruptive episodes, with a statement of the probable conditions with which they were associated.

In regard to diastrophism this table shows that folding movements closed the Willyama sedimentation, and the Ordovician, Silurian and Devonian periods. The remaining orogenic epochs appear to have occurred within what are usually regarded as geological periods, one at the close of the Burindi (Lower Carboniferous) epoch and the other near the end of the Permo-Carboniferous period. These were less widespread in their effects, so far as the present land-areas are concerned, but it is highly probable that their incidence extended, far to the eastward of the present coast-line, into Tasmantis (Sussmilch and David, 1920), that "lost land" now sunk beneath the waves of the Tasman Sea.

The table also shows that, as in other parts of the world, subsidence and geosynclinal sedimentation were accompanied by volcanic eruptions. Rocks of the spilitic suite have been shown to be interbedded with the sediments, sometimes radiolarian, of Ordovician, Silurian and Devonian age, and though few true spilites have as yet been recognized, still the repeated association of keratophyres and albitized andesites and other similar rocks with the marine sedimentation is very striking.

As a matter of fact keratophyres and albitized rocks generally have proved to be embarrassingly abundant. Not only are they found in frequent association with deep-water and shallow-water marine deposits, but they are of quite common occurrence among the terrestrial accumulations of the Kuttung Series, and one cannot help at times wondering what is the significance, if any, of albitization, when it is found affecting igneous rocks regardless of situation or affinities, terrestrial and submarine, acid, intermediate and basic, calcic, monzonitic and alkaline. The one common tectonic factor which may have been potent in regard to all the Palaeozoic occurrences is that of vertical movement, generally of subsidence, but in the case of the South Coast latitic lavas, probably of slow elevation.

There is a general absence of signs of continental vulcanicity before Kuttung times. Harper (1920) has doubtfully attributed certain andesites near Blayney to continental eruptions of early Silurian age, and he looks on the Murrumbidgee (Lower Devonian?) lavas near Yass as being subaërial extravasations, but there appears to be nothing in the way of plateau-basalts, or of alkaline lavas or intrusions, or of massive sills or dykes of quartz-dolerite.

The only possible exceptions appear to be a few quartz-dolerite intrusions, of quite unknown geological age, at Goulburn and Bredbo, to the north of Cooma, and it appears that the products of any such continental eruptive activity, if they ever existed, were always removed by erosion before the next period of deposition commenced.

With the mountain-building movements abyssal injection was generally associated, though granite bathyliths of late-Burindi age are yet to seek. The plutonic intrusions in general form differentiated complexes of calcic affinities, as is usual elsewhere. Probably the dominant Palaeozoic rock-type is a granite approaching quartz-monzonite, of medium acidity, and containing biotite, hornblende, and a noteworthy proportion of plagioclase in addition to the orthoclase; among the limited exposures of pre-Cambrian rocks, however, a true biotite-granite is perhaps the most common type. The intrusions of ultrabasic rocks display a strong tendency to linear arrangement, probably symptomatic of the conditions of their injection.

It is a singular fact that, in spite of the frequency of large-scale vertical crustal movements throughout the Palaeozoic Era, no major intrusions of alkaline plutonic

Table showing Relations between Sedimentation and Contemporaneous

Era, Period or Epoch.	Willyama (Archaean).	Upper Ordovician.	Upper Silurian.	Lower Devonian (?).
Conditions of Sedimentation.	Probably marine.	Marine.	Marine.	Continental (?) and marine.
Nature of Contemporaneous Vulcanicity.	Absent probably.	Tuffs; flows of albitized andesite; rhyolites of Upper Murrumbidgee, and sills of quartz-porphyry.	Tuffs, keratophyres, albitized rhyolites and andesites; acid "intrusive tuffs".	Tuffs and keratophyres of the Murrumbidgee; tuff and spilite of Great Serpentine Belt.
Nature of Closing Diastrophism.	Intense folding with much metamorphism.	Intense folding; metamorphism not so pronounced as in Willyama Series, and variable in degree.	Folding marked, but metamorphic effects not very great.	Not known.
Nature of Igneous Intrusions.	Sills, lenses and phacolites of granite-gneiss, with pegmatite and gabbro. *N.B.*—The massive granite of Mundi Mundi and the uralitic dolerites may be Proterozoic.	Acid granite-gneiss with pegmatite and hornblende-gabbro.	Gneissic quartz-diorite, granite and aplite, with amphibolite and pegmatite; granite-porphyry of Michelago.	None known.

rocks have been discovered, with the possible exception of the Mt. Dromedary mass, which may belong to an epoch near the end of Permo-Carboniferous, a time when vertical forces were operating to produce slow emergence.

If this Mt. Dromedary intrusion is really to be linked with the Illawarra flows and the laccoliths of Milton, then indeed it has a significance unique in our geological history. For here we have an alkaline eruption, complete in all three phases, volcanic, hypabyssal and plutonic, standing Janus-like, looking back upon a long era, now closed, of diastrophic convulsions, and at the same time looking forward to that period of relative tranquillity and freedom from orogeny that has lasted to the present day; heralding, too, on the newly-emerged land-surface, that mighty volume of alkaline and subalkaline magma which in Tertiary times invaded the crust and deluged the State with lava throughout its length and more than half its width.

During the gathering of the material for this address one could not but be impressed by the magnitude of the gaps in our knowledge of the geology of the State, and no less by the extent of the work already accomplished, in little more than two generations.

For an area of the size of New South Wales, whose geological past has been so eventful, the elucidation of all the problems that present themselves is a mighty

Vulcanism, Diastrophism and Igneous Intrusion in New South Wales.

Middle Devonian.	Upper Devonian.	Burindi.	Kuttung.	Permo-Carboniferous (to end of Upper Marine).
Marine.	Marine, mainly shallow water, but deeper to the east.	Marine.	Continental.	Marine and freshwater.
Keratophyre flows and tuffs of Murrumbidgee; ? spilites, keratophyres, tuffs, etc., of Great Serpentine Belt.	Spherulitic rhyolites and quartz-keratophyres, basalts, acid tuffs and breccias.	Acid tuffs and andesitic lavas.	Andesites, toscanites, rhyolites and rhyolitic tuffs, all much albitized; keratophyre, a little basalt.	Alkalized basalts, rhyolitic tuffs and breccias; trachytes, keratophyres, andesites and rhyolites of Drake; latitic lavas of Illawarra.
Not known.	Moderate to intense folding, dying out to east.	? Folding localized in New England, overthrusting along Great Serpentine Belt; elsewhere vertical uplift.	No folding known; gradual subsidence.	Intense folding in New England, but dying out to west and south, where movements were of vertical uplift.
None known.	Bathyliths of granite, quartz-monzonite, grano-diorite and quartz-diorite, gabbro and norite. Dykes and sills of quartz-felsite, quartz-porphry and quartz-porphyrite. ? Ultrabasic intrusions of Cootamundra, Berthong, Gundagai, etc.	? Ultrabasic and basic intrusions of Great Serpentine Belt and serpentines of Port Macquarie, Gordonbrook, etc. ? Some granites of New England.	None known.	New England granitic suite, including quartz-porphyrite, porphyritic and acid granites, aplites and lamprophyres. Monzonite-porphyry of Milton. ? Mt. Dromedary monzonite intrusion with basic and alkaline differentiates.

task, and unfortunately the labourers in this truly great harvest have ever been but few. Nevertheless, when we contemplate the rich store of geological achievement already garnered by our fellow-workers of the present and the past, depression gives place to pride, and we are inspired to go forward and face the future with high hope and a good courage.

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EXPLANATION OF PLATE A.

Map of New South Wales showing the positions of the principal metallic ore-deposits and their relations to some of the areas of deposition, folding and igneous intrusion.

[*Note.*—This map is a copy, with additions, of that forming Plate v in "The Mineral Industry of New South Wales" (Dept. of Mines, 1928), and is reproduced by kind permission of the Under-Secretary for Mines.]

Mr. E. Cheel, Honorary Treasurer, presented the balance sheets for the year 1928, duly signed by the Auditor, Mr. F. H. Rayment, Chartered Accountant (Aust.); and he moved that they be received and adopted, which was carried unanimously.

No nominations of other Candidates having been received, the Chairman declared the following elections for the ensuing Session to be duly made:—

President: H. S. H. Wardlaw, D.Sc.

Members of Council: E. C. Andrews, B.A., E. Cheel, T. Storie Dixson, M.B., Ch.M., A. F. Basset Hull, Prof. T. G. B. Osborn, D.Sc., H. S. H. Wardlaw, D.Sc.

Auditor: F. H. Rayment, F.C.P.A.

A cordial vote of thanks to the retiring President was carried by acclamation.

Linnean Society of New South Wales

GENERAL ACCOUNT. Balance Sheet at 31st December, 1928.

LIABILITIES.	£ s. d.	£ s. d.
Capital: Amount received from Sir Wm. Macleay during his lifetime	14,000 0 0	
Further sum bequeathed by his Will	6,000 0 0	
		20,000 0 0
Contingencies Reserve		9,900 0 0
Income A/c at 31st December, 1928		184 14 2
Fletcher Memorial Fund at 31st December, 1928		23 17 0
		£30,108 11 2

ASSETS.	£ s. d.	£ s. d.
Society's Freehold		11,000 0 0
Investments: Commonwealth Loans	10,674 11 0	
N.S.W. Debentures	470 0 0	
Loans on Mortgage	6,600 0 0	
		17,744 11 0
Cash: Current A/c	808 6 5	
Savings Bank	545 13 9	
In hand	10 0 0	
		1,364 0 2
		£30,108 11 2

INCOME ACCOUNT. Year Ended 31st December, 1928.

	£ s. d.	£ s. d.
To Salaries and Wages		1,062 5 0
„ Printing Publications	782 3 0	
„ Illustrations	137 19 10	
		920 2 10
„ Rates and Insurance		249 13 10
„ Postage	54 0 6	
„ Petty Cash	34 9 4	
		88 9 10
„ Audit	7 7 0	
„ Printing and Stationery	36 6 0	
„ Expenses	62 14 11	
„ Attendance	6 16 3	
„ Bank Expenses	1 10 0	
„ Repairs	15 3 0	
		129 17 2
„ Library and Bookbinding		175 12 4
„ Appropriation: Contingencies Reserve		900 0 0
„ Balance to 1929		184 14 2
		£3,710 15 2

	£ s. d.	£ s. d.
By Balance from 1927		292 11 8
„ Subscriptions: 1928	142 16 0	
Arrears	12 12 0	
In Advance	2 2 0	
		157 10 0
„ Life Subscriptions		31 10 0
„ Entrance Fees		8 8 0
„ Interest		1,091 0 11
„ Rents		799 11 5
„ Sales (including 100 copies of Proceedings purchased by Government of New South Wales)		208 1 8
„ Fellowships A/c (surplus income transferred)		1,122 1 6
		£3,710 15 2

Examined and found correct. Securities produced.
F. H. RAYMENT,
Chartered Accountant (Aust.).
Sydney, 16th February, 1929.

EDWIN CHEEL,
Hon. Treasurer.
Sydney, 16th January, 1929.

LINNEAN MACLEAY FELLOWSHIPS ACCOUNT.

BALANCE SHEET at 31st December, 1928.

LIABILITIES.	£	s.	d.
Amount bequeathed by Sir Wm. Macleay	35,000	0	0
Surplus Income capitalized	11,385	0	0
	£46,385	0	0

ASSETS.	£	s.	d.
Commonwealth Loans	9,040	0	0
N.S.W. Debentures	530	0	0
Loans on Mortgage	34,950	0	0
Norton, Smith & Coy.	1,630	0	0
Commercial Banking Coy., of Sydney, Ltd.	235	0	0
	£46,385	0	0

INCOME ACCOUNT. Year Ended 31st December, 1923.

	£	s.	d.
To Salaries of Linnean Macleay Fellows	866	13	4
„ Fellows' Subsidies	75	7	6
„ Capital A/c	735	0	0
„ General A/c	1,122	1	6
	£2,799	2	4

	£	s.	d.
By Interest	2,799	1	11
„ Commonwealth Loan Adjustment	0	0	5
	£2,799	2	4

Examined and found correct. Securities produced.

F. H. RAYMENT,
Chartered Accountant (Aust.).

Sydney, 6th February, 1929.

EDWIN CHEEL,
Hon. Treasurer.

Sydney, 16th January, 1929.

BACTERIOLOGY ACCOUNT.

BALANCE SHEET at 31st December, 1928.

LIABILITIES.	£	s.	d.	ASSETS.	£	s.	d.	£	s.	d.
Amount bequeathed by Sir Wm. Macleay	12,000	0	0	Commonwealth Loans				15,300	0	0
Accumulated Income capitalized	3,800	0	0	Cash: Commercial Banking Company	445	2	1			
Income A/c at 31st December, 1928	78	17	3	Government Savings Bank ..	133	15	2			
								578	17	3
	£15,878	17	3					£15,878	17	3

INCOME ACCOUNT. Year Ended 31st December, 1928.

	£	s.	d.		£	s.	d.
To Expenses	82	4	6	By Balance from 1927	1,194	16	6
„ Capital A/c	1,800	0	0	„ Interest	766	5	3
„ Balance to 1929	78	17	3				
	£1,961	1	9		£1,961	1	9

Examined and found correct. Securities produced.

F. H. RAYMENT,
Chartered Accountant (Aust.).
Sydney, 16th February, 1929.

EDWIN CHEEL,
Hon. Treasurer.
Sydney, 16th January, 1929.

ABSTRACT OF PROCEEDINGS.

ORDINARY MONTHLY MEETING.

27th March, 1929.

Dr. H. S. H. Wardlaw, President, in the Chair.

The Donations and Exchanges received since the previous Monthly Meeting (28th November, 1928) amounting to 70 Volumes, 421 Parts or Numbers, 43 Bulletins, 9 Reports and 6 Pamphlets, received from 170 Societies and Institutions and 2 private donors, were laid upon the table.

PAPERS READ.

1. Australian Pyrgotidae (with an Appendix by J. R. Malloch). By M. Bezzi. (*Communicated by Dr. I. M. Mackerras.*)

2. A New Species of *Lygosoma* from New South Wales. By J. R. Kinghorn, C.M.Z.S.

3. On Placentation in Reptiles. No. i. By H. Claire Weekes, B.Sc., Linnean Macleay Fellow of the Society in Zoology.

4. Preliminary Note on Monzonitic and Nepheline-bearing Rocks of Mount Dromedary, N.S.W. By Ida A. Brown, B.Sc., Linnean Macleay Fellow of the Society in Geology.

ORDINARY MONTHLY MEETING.

24th April, 1929.

Dr. H. S. H. Wardlaw, President, in the Chair.

Mr. William Boardman, Australian Museum, Sydney; Professor W. J. Dakin, The University, Sydney; Messrs. Cedric Deane, Malvern, Victoria; Tom Iredale, Australian Museum, Sydney; H. G. Raggatt, Epping; and G. H. Wright, Ashfield, were elected Ordinary Members of the Society.

The President announced that the Council had elected Dr. G. A. Waterhouse, Messrs. A. F. Basset Hull and H. J. Carter and Dr. W. R. Browne to be Vice-Presidents, and Mr. E. Cheel to be Honorary Treasurer for the current Session.

The President announced that the Council had provided for the possibility of supplementing, from the General Fund, the payments made to Linnean Macleay Fellows, and has resolved that, under certain conditions, an additional sum not exceeding £100 per annum may be paid from the General Fund to a Fellow in the second and successive years of his tenure.

The President referred to the death of Mr. A. A. Hamilton, which took place at his home at Ashfield on 23rd April. Mr. Hamilton had been a member of the Society since 1899, had contributed seven papers to the Proceedings, and for many years was a very constant exhibitor of interesting specimens at the meetings of the Society.

A letter was read from the New South Wales State Committee of the Council for Scientific and Industrial Research stating that lists are being prepared of the

popular names of local flora in use in the various States and asking for information regarding names of local plants. Members who had any information regarding local names for plants were asked to assist by forwarding the same to Mr. I. G. Mackay, Secretary of the New South Wales State Committee, The University, Sydney.

A letter was read from Dr. N. A. Cobb, a former member of the Society, and contributor to the PROCEEDINGS between 1890 and 1898 (chiefly on Nematodes) expressing his interest in and appreciation of the late Professor Harrison's Presidential Address and asking to be remembered to those of his contemporaries who are still members of the Society.

The Donations and Exchanges received since the previous Monthly Meeting (27th March, 1929) amounting to 7 Volumes, 109 Parts or Numbers, 5 Bulletins, 2 Reports and 2 Pamphlets, received from 57 Societies and Institutions and 1 private donor, were laid upon the table.

PAPERS READ.

1. On the Type Locality of Certain Flies described by Macquart in "Diptères Exotiques, Supplement 4." By G. H. Hardy.

2. Notes on the Identity of described Australian Flies of the Genus *Cerdistus* (Asilidae). By G. H. Hardy.

3. Notes on Australian Diptera. No. xix. By J. R. Malloch. (*Communicated by Dr. I. M. Mackerras.*)

4. Australian Coleoptera. Notes and New Species. No. vi. By H. J. Carter, B.A., F.E.S.

5. Fishes from Ongtong Java, Melanesia. By G. P. Whitley.

6. A Preliminary Account of the Origin of Two New Australian Physiologic Forms of *Puccinia graminis tritici*. By W. L. Waterhouse.

NOTES AND EXHIBITS.

Mr. D. G. Stead referred to efforts that were being made by the Wild Life Preservation Society to bring the Native Bear back to suitable districts around Sydney.

Mr. W. W. Froggatt exhibited a five months old seedling of *Acacia stenophylla* showing the bipinnate leaves at the tips of the petioles. This wattle grows along the banks of the Murray and other inland rivers and is remarkable for its very long slender flattened leaves drooping like a willow. It throws up suckers from exposed roots on the river banks, and an old tree is often surrounded with a thicket of suckers. In a larger specimen growing at Croydon the first twelve petioles bear bipinnate leaves, but the next two pairs are simple slender leaves like the foliage of the old trees.

Mr. Froggatt also exhibited a pair of sawflies (*Perga* sp.) which were collected in the larval state feeding upon the foliage of a Mallee (*Eucalyptus oleosa*) on 16th October, 1928. Placed in a tin, they pupated, and at the end of February, 1929, three pairs emerged at intervals of two or three days.

Mr. A. S. Le Souef exhibited a skin of a Tree Kangaroo, *Dendrolagus dorianus* Ramsay, from Edie Creek Gold Field, New Guinea. This is only the third skin of this species that has been secured. It confirms a very interesting feature, in having the hair of the back reversed from the rump, indicating that the animal must habitually sit in a crouched position.

ORDINARY MONTHLY MEETING.

29th MAY, 1929.

Dr. H. S. H. Wardlaw, President, in the Chair.

Dr. H. R. Angell, Sydney, and Mr. John Mann, Brisbane, Queensland, were elected Ordinary Members of the Society.

A letter was read from Mrs. A. A. Hamilton and family, returning thanks for sympathy.

The President announced that the Council has agreed to join with the Royal Society of New South Wales and the Institution of Engineers, Australia, in erecting Science House on the site which is being given to the three institutions at the corner of Essex and Gloucester Streets, Sydney.

The President offered the congratulations of Members to Dr. A. J. Nicholson and Dr. G. D. Osborne on having been admitted to the degree of Doctor of Science in the University of Sydney.

The President also offered Dr. Walkom the best wishes of Members for a very pleasant and profitable trip in attending the meeting of the British Association in South Africa in July.

The Donations and Exchanges received since the previous Monthly Meeting (24th April, 1929) amounting to 13 Volumes, 94 Parts or Numbers, 5 Bulletins, 4 Reports and 13 Pamphlets, received from 63 Societies and Institutions and 2 private donors, were laid upon the table.

PAPERS READ.

1. Revision of the Australian Phoracanthini (Fam. Cerambycidae), with Notes, and Descriptions of New Species of this Group and of Allied Genera. By H. J. Carter, B.A., F.E.S.

2. Notes on the Australian Species of *Molophilus* (Tipulidae, Diptera). By C. P. Alexander. (*Communicated by Dr. I. M. Mackerras.*)

3. Papuan Grasses collected by L. J. Brass. By A. S. Hitchcock. (*Communicated by Mr. C. T. White.*)

4. Note on a Fossil Wood from Central Australia. By A. B. Walkom, D.Sc.

NOTES AND EXHIBITS.

Mr. A. S. Le Souef exhibited a skin of a Tree Kangaroo (*Dendrolagus*) from upper Strickland River, Papua, which is probably a new species. This specimen is characterized by short coarse hair which is reversed from the middle of the back.

Mr. W. L. Waterhouse exhibited living specimens of *Berberis vulgaris* infected with *Puccinia graminis*. The spermagonial and oecidial stages were present. Specimens of self-sown wheat heavily infected with the uredospore and teleutospore stage of the same pathogen were also shown.

ORDINARY MONTHLY MEETING.

26th JUNE, 1929.

Dr. H. S. H. Wardlaw, President, in the Chair.

The President announced that Professor W. J. Dakin had been elected a member of Council to fill the vacancy caused by the resignation of Dr. I. M. Mackerras.

The President announced that the Walter Burfitt Prize had been awarded to Dr. N. D. Royle by the Royal Society of New South Wales.

The President referred with pleasure to the proclamation issued by the Government extending the existing protection to certain species of wild flowers for a further period of twelve months.

The Donations and Exchanges received since the previous Monthly Meeting (29th May, 1929) amounting to 27 Volumes, 150 Parts or Numbers, 11 Bulletins, 11 Reports and 7 Pamphlets, received from 86 Societies and Institutions and 1 private donor, were laid upon the table.

PAPERS READ.

1. Calcareous Concretions in the Upper Marine Series, Singleton District, N.S.W. By H. G. Raggatt, B.Sc.

2. Notes on the Ceroplatinae, with Descriptions of New Australian Species. By F. W. Edwards. (*Communicated by Dr. I. M. Mackerras.*)

3. A Garnet-bearing Dyke near Moruya, N.S.W. By Ida A. Brown, B.Sc., Linnean Macleay Fellow of the Society in Geology.

NOTES AND EXHIBITS.

Mr. E. Cheel exhibited specimens of *Xanthium chinense* Miller (Syn. *X. occidentale* Bertoline), Family Compositae. This plant is a common weed in the coastal districts of this State and Queensland and was also collected at Lautoka in the Fijian Islands in 1918 by the exhibitor. It is commonly known as "Noogoora Burr" in Australia and has been listed by certain Australian botanists in various works under the name *Xanthium strumarium*. The latter species has much smaller burrs than *X. chinense* and, so far as can be ascertained, *X. strumarium* of Linnaeus has not been found in a naturalized condition in this State. Specimens of the common "Sea-side Barley Grass" (*Hordeum maritimum* With.) were also exhibited. This plant is naturalized in the Orange district and several other districts and has been listed in several weed lists as *Hordeum nodosum* (*H. seculinum*). The latter species has not been found, so far as can be ascertained, in any part of Australia as a naturalized species.

Mr. E. Cheel exhibited, for Dr. G. P. Darnell Smith, live plants of *Sarrcenia Drummondii*, which he brought from North Carolina, U.S.A., during his recent visit. The plants were thriving in the hot-house of the Botanic Gardens, and it was noteworthy that large numbers of small ants were captured and used as food.

Mr. W. L. Waterhouse exhibited specimens of *Bremia Lactucae* L., the causal fungus of the Downy Mildew of lettuce. The material was first collected at Pennant Hills, N.S.W., by Miss Lilian Fraser and has since been found on lettuces offered for sale in Sydney. This is a first record for New South Wales and also, it is believed, for Australia.

Dr. G. A. Waterhouse exhibited an almost complete fossil insect from Beacon Hill Quarry, Brookvale, near Sydney. The fossil was found in shale in the Hawkesbury Series about 500 feet above the Chocolate Shale of the Narrabeen Series, and is from the same beds as *Mesotitan scullyi* Tillyard and a number of at present undescribed insect remains. The specimen in question is about three and a half inches long and shows both forewings, underneath which are the hindwings and nearly the whole of the dorsal surface of the head and thorax. The insect is allied to the Homoptera, and bears a resemblance to the modern *Cicada*.

Mr. H. G. Raggatt exhibited concretions from the Crinoidal Stage of the Upper Marine Series, Permian System, from a railway cutting about fifteen chains east of Antiene Railway Station.

ORDINARY MONTHLY MEETING.

31st JULY, 1929.

Dr. H. S. H. Wardlaw, President, in the Chair.

Miss C. M. Joyce Allan, Australian Museum, Sydney, was elected an Ordinary Member of the Society.

The President referred to the death of Sir Baldwin Spencer, who had been a Corresponding Member of the Society since 1893. A letter of sympathy had been forwarded to Lady Spencer.

The President offered the congratulations of members to Miss H. Claire Weekes, Linnean Macleay Fellow of the Society in Zoology, on the award to her of a Rockefeller Scholarship.

The Donations and Exchanges received since the previous Monthly Meeting (26th June, 1929) amounting to 25 Volumes, 178 Parts or Numbers, 24 Bulletins, 8 Reports and 14 Pamphlets, received from 91 Societies and Institutions and 1 private donor, were laid upon the table.

PAPERS READ.

1. Notes on Australian Diptera. xx. By J. R. Malloch. (*Communicated by Dr. I. M. Mackerras.*)

2. Some New Species of *Stenetrium* from Western Australia. By G. E. Nicholls, D.Sc. (*Communicated by Mr. T. C. Roughley.*)

3. Note on the Structural and Tectonic Geology of the Hunter Valley between Greta and Muswellbrook, with Special Reference to the Age of the Diastrophism. By H. G. Raggatt, B.Sc.

4. Fourth Contribution towards a New Classification of the Australian Asilidae. By G. H. Hardy.

NOTES AND EXHIBITS.

Dr. G. A. Waterhouse exhibited several Australian species of moths belonging to the genus *Charagia*, including *Ch. scripta*, male and female, from Western Australia, *Ch. ramsayi*, male and female, and *Ch. daphnandrae*, male, from Toowoomba, Queensland.

ORDINARY MONTHLY MEETING.

28th AUGUST, 1929.

Dr. G. A. Waterhouse, B.E., F.E.S., Vice-President, in the Chair.

The Chairman announced that the Council had accepted Miss H. Claire Weekes' resignation from her Linnean Macleay Fellowship in Zoology and that Miss Weekes had sailed on 22nd instant for England to take up her work under a Rockefeller Scholarship.

The Chairman also announced that Mr. H. L. Jensen, Macleay Bacteriologist to the Society in succession to the late Dr. R. Greig Smith, would arrive from England on 19th September.

The Donations and Exchanges received since the previous Monthly Meeting (31st July, 1929) amounting to 14 Volumes, 139 Parts or Numbers, 14 Bulletins, 1 Report and 11 Pamphlets, received from 60 Societies and Institutions, were laid upon the table.

PAPERS READ.

1. Notes on Gall-making Coccids and Descriptions of New Species. By W. W. Froggatt, F.L.S.

2. The Food Plants or Hosts of some Fijian Insects. iii. By W. Greenwood, H.D.A.

3. The Life-history of *Doryanthes excelsa*. Part ii. The Gametophytes, Seed Production, Chromosome Number and General Conclusion. By I. V. Newman, M.Sc.

NOTES AND EXHIBITS.

Mr. W. W. Froggatt exhibited Brachyscelid galls described in his paper entitled "Notes on Gall-making Coccids and Descriptions of New Species", read at the meeting. Mr. Froggatt also exhibited damaged foliage of the Tasmanian Blue Gum (*Eucalyptus globulus*) growing in the avenues at Canberra, which has been infested by the Blue Gum foliage moth (*Mnesampla privata* Gn.). In the middle of June the curled leaves were full of larvae feeding on the surface of the leaves. Early in August not a single pupa could be found, and all the caterpillars had vanished; nor could a single pupa be found in the curled webbed foliage, on the tree trunks or in the ground under the trees, though pupae were found in the foliage, bred from larvae, kept in a tin at the School of Forestry. French figures this small reddish-brown moth in his "Destructive Insects of Victoria", pt. iii, pl. 54. He does not, however, mention its pupating habits.

Mr. W. L. Waterhouse exhibited specimens of oat seedlings infected by *Puccinia graminis avenae*. In one case the commonest of the Australian physiologic forms was used to infect the plants. The result was complete susceptibility and the production of many crops of uredospores up to the time that the rust killed the leaves. This is the normal happening in seedling infection. In the second case the rust used to bring about the infection was an Irish physiologic form which had been obtained from the barberry infections. The result in this case was again complete susceptibility, but an unusual happening was the very rapid production of teleutospores within a month of inoculation. Several other striking differences are exhibited by this Irish rust.

Mr. I. V. Newman exhibited branches from two specimens of *Acacia continua* growing at Broken Hill. There is a distinct difference in the general appearance of these two branches. One is generally sturdier. The overall size of the bushes is, however, equal. Another difference is a longitudinal marking clearly shown on the stems of the sturdier one, but only very faintly to be seen (if at all) on the more slender one. This is another example of the small differences of form to be found in many species of *Acacia*, especially in the *Baileyana-decurrens-discolor* complex of species. For this reason there is much confusion in the taxonomy of the Acacias. The exhibitor has begun an investigation of this problem from the cytological point of view, concentrating first of all on the above complex of species of bi-pinnate Acacias.

ORDINARY MONTHLY MEETING.

25th SEPTEMBER, 1929.

Dr. H. S. H. Wardlaw, President, in the Chair.

The President, on behalf of the Society, offered a hearty welcome to Mr. H. L. Jensen, Macleay Bacteriologist to the Society, and wished him a very successful career in his new sphere of work.

The President offered the congratulations of members to Mr. J. H. Campbell, I.S.O., on the honour conferred on him by His Majesty the King.

The President announced that the Council is prepared to receive applications for four Linnean Macleay Fellowships tenable for one year from 1st March, 1930, from qualified candidates. Applications should be lodged with the Secretary, who would afford all necessary information to intending candidates, not later than Wednesday, 6th November, 1929.

The President announced with pleasure that the Minister for Lands had received a deputation from scientific societies and had agreed to appoint a representative nominated by them to fill one of the vacancies on the National Park Trust. Professor T. G. B. Osborn had been unanimously nominated by the scientific societies as their representative.

The President also announced that word had been received from Dr. Walkom of his safe arrival at Fremantle after an excellent voyage from South Africa and that he is expected to return to Sydney during the first week in October.

The Donations and Exchanges received since the previous Monthly Meeting (28th August, 1929) amounting to 5 Volumes, 97 Parts or Numbers, 5 Bulletins, 1 Report and 1 Pamphlet, received from 48 Societies and Institutions, were laid upon the table.

PAPERS READ.

1. Notes on Australian Diptera. xxi. By J. R. Malloch. (*Communicated by Dr. I. M. Mackerras.*)

2. Revision of Australian Geometridae (Lepidoptera). By G. M. Goldfinch.

3. Some Aspects of the Structural Geology of the Carboniferous Rocks in the Hunter River District between Raymond Terrace and Scone. By G. D. Osborne, D.Sc.

NOTES AND EXHIBITS.

Mr. G. M. Goldfinch exhibited a large collection of species of the Geometridae, dealt with in his paper.

Mr. E. Cheel exhibited four forms or subspecies of grasses commonly known as "Kangaroo Grass" (*Themeda* spp.): (i) *Themeda australis* (R. Br.) Stapf, the common form in Port Jackson district and along the coast to Queensland and southwards to Eden; (ii) *Themeda grandiflora* (Hooker). This is figured in "Flora Tasmania" and was included with the Port Jackson form under *Anthistiria ciliata* by Bentham. So far as can be ascertained the true *Anthistiria ciliata* (which is a native of India) has not yet been found in Australia; (iii) *Themeda* sp., a form exhibited at a meeting of this Society (see PROCEEDINGS, 1912, p. 393) with the sheathing bracts and spikelets more or less covered with tubercle-based bristles; (iv) *Themeda* sp., a form with the nodes more or less pubescent, and the lower part of stem and leaf-sheaths copiously sprinkled with hairs. These forms

or subspecies are being cultivated and some interesting races are being produced as a result of cross-pollination.

Mr. W. W. Froggatt exhibited an adult and two larval specimens of an Homopterous insect, *Achilus flammeus* (Family Achilidae) found in the nest of the common termite, *Coptotermes lacteus*. Nothing was previously known about the life-history of this handsome bright red froghopper, which is evidently an inquiline in the termitaria of our white ants. The exhibitor has never taken this insect in the bush, but on several occasions has found it on windows. The lady of the house where this large active nest was opened stated that in the previous summer she had found a number of these insects on the carpets. Apparently they had emerged from the same nest.

Mr. W. L. Waterhouse exhibited specimens of Federation and Webster wheats showing a striking difference in regard to flag smut susceptibility. Webster was imported from U.S.A. on account of its strong resistance to rust. In pot tests, made in 1928 and repeated in 1929, Webster grain heavily covered with flag smut spores has produced perfectly healthy plants, whilst grain of Federation and Waratah treated in exactly the same way has produced plants heavily infected with flag smut. Webster, therefore, promises to give valuable results from crosses with commercial varieties of Australian wheats.

Mr. Gilbert P. Whitley submitted notes on the identity of some little known Fishes. He had recently identified several species which had been described many years ago but had not since been recognized.

Sparus bandatus was diagnosed as a new species in 1810 in Perry's "Arcana," a very rare work. Perry's figure, however, is so similar to those of Bloch (1791) and of Shaw and Nodder (1806) as to appear as if it had been copied from them. Thus *Sparus bandatus* Perry = *Cheilinus fasciatus* (Bloch). On plate 76 of "The Naturalist's Repository," published in 1824, Donovan figured *Balistes australis* from Van Diemen's Land. His name has been generally overlooked and *Monacanthus rudis* Richardson, 1844, is apparently a synonym of it. The species, which is closely allied to *Monacanthus setosus* Waite, 1899, may now be known as *Cantherines australis* (Donovan). Castelnau (*Proc. Zool. Acclim. Soc. Vict.* ii, 1873, p. 118) described a supposed new Scopelid fish as *Neosudis vorax* from New Caledonia, and subsequent investigators have protestingly placed it with the Iniomi whilst acknowledging their inability to suggest its relationships with members of that Order. Analysis of Castelnau's account shows, however, that *Neosudis* is a Clupeoid fish of the genus *Chirocentrus*, and, in the speaker's opinion, Castelnau's so-called species can only be regarded as a Pacific subspecies of the Wolf Herring, *Chirocentrus dorab vorax* (Castelnau).

ORDINARY MONTHLY MEETING.

30th October, 1929.

Dr. H. S. H. Wardlaw, President, in the Chair.

Mr. H. L. Jensen, Woollahra, and Mrs. K. M. Sherrard, M.Sc., Cremorne, were elected Ordinary Members of the Society.

The President expressed the Society's congratulations to Dr. R. Broom, F.R.S., Corresponding Member of the Society, on the award to him of the South African Medal for 1929 by the South African Association for the Advancement of Science and also on the award of the honorary degree of Doctor of Science by the University of Capetown on the occasion of its centenary celebrations, October, 1929.

The President offered the congratulations of members to Dr. A. J. Nicholson on his appointment as Deputy Chief of the Department of Economic Entomology of the Council for Scientific and Industrial Research.

Candidates for Linnean Macleay Fellowships, 1930-31, were reminded that Wednesday, 6th November, was the last day for receiving applications.

The Donations and Exchanges received since the previous Monthly Meeting (25th September, 1929) amounting to 23 Volumes, 169 Parts or Numbers, 8 Bulletins, 3 Reports and 6 Pamphlets, received from 66 Societies and Institutions and 1 private donor, were laid upon the table.

PAPERS READ.

1. Revision of Australian Oenochromidae (Lepidoptera). Part i. By A. Jefferis Turner, M.D., F.E.S.

2. Variations in certain Orchids. By Rev. H. M. R. Rupp, B.A.

3. A List of the Australian Bombyliidae of the Subfamilies Exoprosopinae, Anthracinae and Bombyliinae in the German Entomological Museum, Berlin. By Frederick H. S. Roberts, M.Sc.

4. Descriptions of New Species of Australian Coleoptera. Part xx. By A. M. Lea, F.E.S.

5. Notes on Australian Diptera. No. xxii. By J. R. Malloch. (*Communicated by Dr. I. M. Mackerras.*)

NOTES AND EXHIBITS.

Mr. E. Cheel exhibited a drawing, together with portions of a frond taken from a "Tree Fern" collected at Barrington Tops by the late Professor L. Harrison in March, 1925. The late Mr. T. Whitelegge suggested that the fern was an undescribed species of *Hemitelia*. Although several attempts have been made to collect additional material, they have been unsuccessful. As there are upwards of fifty species of the genus known to science, including certain Australian and New Guinea species which are imperfectly known, it is necessary to have complete material before the exact identification can be finalized.

Mr. David G. Stead exhibited a photograph of a specimen of the rarely seen "Lesser Killer," *Pseudorca crassidens*, which had been cast up on the ocean beach at Bulli, on the South Coast of New South Wales. This is the cetacean which caused such a sensation in Great Britain during November, 1927, when 120 were cast up in Dornoch Firth a little to the north of the Moray Firth in Scotland. A lapse of eighty years had taken place between the previous British record and this one. The Bulli specimen was fifteen feet in length.

The nearest genus to this is *Orca*, the well-known Killer or Killer Whale, which attains a length of thirty feet. It is on the coast at the present time, where it has been reported to be attacking Humpback whales, *Megaptera*.

Mr. A. S. Le Souef exhibited a skin of a Rock Wallaby (*Petrogale penicillata*) that had been acclimatized on Kawau Island, New Zealand. Owing to changed environment the specimen showed much brighter markings than specimens from Australia.

Dr. A. B. Walkom exhibited a perspective drawing of the proposed Science House, made by the architects, Messrs. Peddle, Thorp and Walker, which had recently been shown in an exhibition in Sydney. He also laid on the table for

the perusal of members a communication on volcanoes forwarded by Miss Georgina King.

Dr. Walkom gave a short account of the National Botanic Garden at Kirstenbosch, Capetown, a reserve of about 1,100 acres purely for the cultivation of the South African flora, and suggested that the example of South Africa in this respect might well be followed in other parts of the world.

It was then unanimously resolved, on the motion of Mr. A. F. Basset Hull, supported by several speakers, "that the State Government be urged to set apart an area of Crown land for the purpose of cultivating, preserving and exhibiting the native flora."

Mr. T. C. Roughley drew attention to a proposal which would result in the drainage of overflow sewage matter into Port Jackson and it was resolved that "The Linnean Society of New South Wales strongly protests against the contemplated action of the Metropolitan Water, Sewerage and Drainage Board to drain overflow sewage matter into Vaucluse Bay and Parsley Bay. It is considered that not only will the health of the community be endangered by the contamination of two such popular swimming beaches, but also that irreparable damage will be done to the marine life of that part of the Harbour."

ORDINARY MONTHLY MEETING.

27th NOVEMBER, 1929.

Dr. H. S. H. Wardlaw, President, in the Chair.

Miss Bertha M. Martin, B.Sc., Chatswood, and Mr. Melbourne Ward, Potts Point, Sydney, were elected Ordinary Members of the Society.

The President announced that the Council had re-appointed Miss Ida A. Brown, B.Sc., and appointed Mr. Frank A. Craft, B.Sc., to Linnean Macleay Fellowships in Geology and Geography respectively for a period of one year from 1st March, 1930.

The President also announced that, in connection with the proposal, made at the last meeting, urging the Government to set apart an area for the purpose of preserving, cultivating and exhibiting the native flora, the Council had appointed the following Committee to take action: Professor T. G. B. Osborn, Messrs. H J. Carter, E. Cheel, A. F. Basset Hull, and A. H. S. Lucas, together with the President and Secretary.

The Donations and Exchanges received since the previous Monthly Meeting (30th October, 1929) amounting to 220 Volumes, 97 Parts or Numbers, 6 Bulletins, 4 Reports and 2 Pamphlets, received from 56 Societies and Institutions and 1 private donor, were laid upon the table.

PAPERS READ.

1. A Revision of the Australian Bombyliidae (Diptera). Part iii. By Frederick H. S. Roberts, M.Sc.

2. On some Recent New Light on the Origin of the Mammals. By Robert Broom, M.D., D.Sc., F.R.S.

3. A further Contribution to our Knowledge of the Flora of New South Wales. By W. F. Blakely.

4. Australian Rust Studies. i. By W. L. Waterhouse, B.Sc.Agr.

5. Australian Mycetophilidae. Synopsis of the Genera. By A. L. Tonnoir. *(Communicated by Dr. A. J. Nicholson.)*

NOTES AND EXHIBITS.

Mr. A. Musgrave exhibited paired male and female examples of a wingless grasshopper of the subfamily Pyrgomorphinae, taken by Mr. H. O. Fletcher and himself at Mt. Kosciusko, between altitudes of 5,000 and 7,000 feet, during January, 1929. The sexes were known hitherto under different names, the male being described as *Monistria vinosa* by Carl in 1916, from a specimen from Mt. Kosciusko, and the female as *Monistria grossa* by Sjöstedt in 1921 and from the same locality. *Monistria vinosa* Carl being the older name, should therefore be used for the species, *M. grossa* Sjöstedt being an absolute synonym. The male is much smaller in size than the female, and measures 23 mm., the females in the series collected measuring 37 mm., though Sjöstedt's specimen measured 40 mm.

Dr. A. B. Walkom exhibited coloured plates of species of South African Proteaceae.

DONATIONS AND EXCHANGES.

Received during the period 29th November, 1928, to 27th November, 1929.

(*From the respective Societies, etc., unless otherwise mentioned.*)

ABERYSTWYTH.

Welsh Plant Breeding Station, University College of Wales.—Bulletin, Series H, No. 9 (1928); Leaflet Series, S, No. 1 (1929); "The Welsh Journal of Agriculture", v (1929).

ACCRA.

Geological Survey of the Gold Coast.—Report for the Period April, 1926–March, 1927 (no date).

ADELAIDE.

Department of Mines: Geological Survey of South Australia.—Annual Report of the Director of Mines and Government Geologist for 1928 (1929); Mining Review for the Half Years ended December 31st, 1928 (No. 49); June 30th, 1929 (No. 50) (1929).

Field Naturalists' Section of the Royal Society of South Australia.—"The South Australian Naturalist", x, 1-4 (1928-1929).

Public Library, Museum and Art Gallery of South Australia.—Forty-fifth Annual Report of the Board of Governors for 1928-1929 (1929).

Royal Geographical Society of Australasia, South Australian Branch.—Proceedings, xxix, Session 1927-28 (1929).

Royal Society of South Australia.—Transactions and Proceedings, lii (1928).

South Australian Ornithological Association.—"The South Australian Ornithologist", x, 1-4 (1929).

University of Adelaide.—"The Australian Journal of Experimental Biology and Medical Science", v, 4 (T.p. & c.) (1928); vi, 1-3 (1929).

Woods and Forests Department.—Annual Report for the Year ended June 30th, 1928 (1928); Forestry Handbook (Empire Forestry Conference, 1928) (1928).

ALBANY.

New York State Library, University of the State of New York.—New York State Museum Bulletin, Nos. 276-278 (1928); New York State Museum Handbook, 4-9 (1928-1929).

ALGER.

Institut Pasteur d'Algérie.—Archives, vi, 2-3 (1928).

Société d'Histoire naturelle de l'Afrique du Nord.—Bulletin, xix, 1928, 5-9 (1928); xx, 1929, 1-5 (1929).

AMSTERDAM.

Nederlandsche Entomologische Vereeniging.—Entomologische Berichten, vii, 162-168 (1928-1929); Tijdschrift voor Entomologie, lxxi, 3-4 (T.p. & c.) (1928); lxxii, 1-2 and Supplement (1929).

Royal Academy of Sciences.—"Science in the Netherlands East Indies" by various authors (prepared for Fourth Pacific Science Congress, 1929) (no date).

ANN ARBOR.

University of Michigan.—Contributions from the Museum of Geology, T.p. & c. for Vol. ii (1928); Contributions from the Museum of Palaeontology (being the continuation of Contributions from the Museum of Geology), iii, 1-4 (1928); Museum of Zoology: Miscellaneous Publication Nos. 18-19 (1928-1929); Occasional Papers, Nos. 187-197, T.p. & c. for Nos. 172-197 (Vol. viii), 1926-1928 (1927-1928); Nos. 198-199 (1929); Papers of the Michigan Academy of Science, Arts and Letters, ix-x, 1928 (1929).

AUCKLAND.

Auckland Institute and Museum.—Annual Report, 1928-29 (1929); Municipal Record, iii, 3 (1929).

BALTIMORE.

Johns Hopkins University.—University Circular, N.S. 1927, 10 (1927); N.S. 1928, 1-10 (1928).

BANDOENG.

Opsporingsdienst Dienst van den Mijnbouw in Nederlandsch-Indië.—Bulletin of the Netherlands East Indian Volcanological Survey, Nos. 13-23 (1928-1929); Vulkanologische en Seismologische Mededeelingen, Nos. 9, 10 (Text and Plates) (1928-1929); Wetenschappelijke Mededeelingen, Nos. 9, 11-12 (1929).

BARCELONA.

Real Academia de Ciencias y Artes de Barcelona.—Boletin, v, 6 (T.p. & c.) (1929); Memorias, xx, 15-16 (T.p. & c.) (1928); xxi, 1-16 (1928-1929); Nomina del Personal Academico, 1928-1929 (1928).

BASEL.

Naturforschende Gesellschaft.—Verhandlungen, xxxix, 1927-1928 (1929).

BERGEN.

Bergens Museum.—Arbok, 1928, 2 (T.p. & c.) (1928); T.p. & c. for Arbok, 1928, Avhandlinger og Arsberetning (1929); 1929, 1 (1929); Arsberetning, 1927-1928 (1928).

BERKELEY.

University of California.—Publications, Botany, xi, 11-15; xiv, 11-20; xv (complete); xvi, 1-2 (1929); Entomology, iv, 12 (1928); v, 1-3 (1929); Geology, xvii, 9-11 (T.p. & c.) (1928); xviii, 1-13 (1928-1929); Physiology, vii, 5-8 (1929); Public Health, i, 1-6 (1929); Zoology, xxx, 13-17 (1928-1929); xxxi, 17-19 (T.p. & c.) (1928-1929); xxxii, 1-3 (1928-1929); xxxiii, 1-6 (1929).

BERLIN.

Botanische Garten und Museum.—Notizblatt, x, 95-97 (1928-1929).

Deutsche Entomologische Gesellschaft, E.V.—Deutsche Entomologische Zeitschrift, 1928, 2-5 (1928-1929).

Deutsche Entomologische Museum.—Entomologische Mitteilungen, xvii, 6 (T.p. & c.) (1918) (*Series concluded*); Supplementa Entomologica, No. 17 (1929) (*Series concluded*).

Notgemeinschaft der Deutsche Wissenschaft.—"Flora", Neue Folge, xxiii, 4 (T.p. & c.) (1928); xxiv, 1 (1929).

Zoologische Museum.—Bericht, 1914, 1915, 1916-1926 (1915, 1916, 1928); Mitteilungen, i-x (complete) (1898-1922); xii, 2 (1926); xiii (complete) (1927); xiv, 1-4 (T.p. & c.) (1928).

BERN.

Naturforschende Gesellschaft.—Mitteilungen a.d. Jahre 1928 (1929); Verhandlungen, 1927 (1927); 1928 (1928).

BIRMINGHAM.

Birmingham Natural History and Philosophical Society.—List of Members, 1929, and Annual Report, 1928; Proceedings, xv, 8, Session 1929-30 (T.p. & c.) (1929).

BLOEMFONTEIN.

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BOLOGNA.

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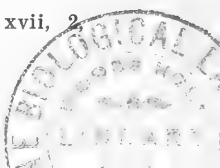

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PAVIA.

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PEKING.

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PERM.

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PERTH.

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PHILADELPHIA.

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PIETERMARITZBURG.

Natal Museum.—Annals, T.p. & c. for v; vi, 2 (1929).

PITTSBURGH.

Carnegie Museum.—Annals, xviii (bound, complete), 1927-1928 (1928).

PLYMOUTH.

Marine Biological Association of the United Kingdom.—Journal, N.S. xv, 3 (T.p. & c.) (1928); xvi, 1 (1929).

PORTICI.

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PRAG.

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PRETORIA.

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PUSA.

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RENNES.

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RICHMOND.

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RIO DE JANEIRO.

Escola Superior de Agricultura e Medicina Veterinaria.—Archivos, ix, 1-2 (T.p. & c.) (1928).

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RIVERSIDE.

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SAN DIEGO.

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SAN FRANCISCO.

California Academy of Sciences.—Occasional Papers, xv-xvi (1928); Proceedings, Fourth Series, xvii, 1-10 (1928); xviii, 1-3 (1929).

SAO PAULO.

Museu Paulista.—Revista, xvi (1929).

SARATOV.

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SEATTLE.

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SENDAI.

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SHANGHAI.

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SHARON.

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SOFIA.

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ST. LOUIS.

Missouri Botanical Garden.—Annals, xv, 3-4 (T.p. & c.) (1928); xvi, 1-2 (1929).

STOCKHOLM.

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TASHKENT.

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TOKYO.

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TRING.

Zoological Museum.—Novitates Zoologicae, xxxiv, 4 (T.p. & c.) (1928); xxxv, 1-2 (1929).

TRONDHJEM.

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URBANA.

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VIENNA.

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WASHINGTON.

Bureau of American Ethnology.—xli-st-xliv-th Annual Reports, 1919-1924, 1924-1925, 1925-1926, and 1926-1927 (1928); Bulletins 84, 86, 87, 89, 92 (1928-1929).

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WELLINGTON.

Department of Scientific and Industrial Research: Geological Survey Branch.—Bulletin, N.S. No. 30 (1928); Geological Memoirs, Memoir No. 1 (1928).

Dominion Museum.—Bulletin, No. 13 (1929); "New Zealand Journal of Science and Technology", x, 3-6 (T.p. & c.) (1928-1929); xi, 1-3 (1929).

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WELTEVREDEN.

Centraal Militair Geneeskundig Laboratorium.—"Filariasis in Ned.-Indië". by S. L. Brug (from *Genees. Tijd. voor Nederl.-Indie*, 68, 5, 1928); "Aanteekeningen omtrent Muskieten (iv)" by S. L. Brug (from *Genees, Tijd. voor Nederl.-Indië*", 68, 7, 1928).

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Woods Hole.

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Wormley.

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Hedley, Mrs., Sydney (donor).—205 volumes from the library of the late Mr. Charles Hedley.

Hudson, G. V., Wellington, New Zealand.—"Some Aspects of Modern Methods in Entomology" (Wellington, 1929).

Kinghorn, J. R., Sydney.—"The Snakes of Australia" (Sydney, 1929).

Meyrick, E., B.A., F.R.S., Marlborough, Wilts, England.—"Exotic Microlepidoptera", iii, 13-17 (1928-1929).

Musson, Mrs., Gordon, Sydney (donor).—From the library of the late Mr. C. T. Musson: British Association for the Advancement of Science, Federal Handbook on Australia. Australian Meeting, 1914 (Melbourne, 1914); Department of Agriculture, N.S.W., Miscellaneous Publication, No. 16—Host and Habitat Index of the Australian Fungi (Sydney, 1893); "Handbook of Field and General Ornithology—A Manual of the Structure and Classification of Birds, etc." by Prof. Elliott Coues (London, 1890); "Handbook of the British Flora; A Description of the Flowering Plants and Ferns indigenous to, or naturalized in, the British Isles" by George Bentham (2 vols.) (London, 1865); Linnean Society of London, General Index to the First Twenty Volumes of the Journal (Botany) and the Botanical Portion of the Proceedings, Nov., 1838, to June, 1886 (London, 1888); "Man and Nature; or, Physical Geography as modified by Human Action", by George P. Marsh (London, 1864); "Silva: or, A Discourse of Forest-Trees, etc." by John Evelyn (2 books in one vol.) (London, 1729); "The Tourist in Wales" and "The Alps, Switzerland, Savoy and Lombardy" by Rev. C. Williams (bound in one vol.) (no date); "The Vegetable Kingdom; or The Structure, Classification and Uses of Plants, illustrated upon the Natural System" by John Lindley (Third Edition, London, 1853); "Victoria; late Australia Felix, or Port Phillip District of New South Wales, etc." by W. Westgarth (Edinburgh, 1853).

Reychler, Lucien, Belgium.—One engraving and two pamphlets—"Concerning the Foundation of a German Research Institute at Muncheberg" and "Indexing Summary as a Guide to the Easy Perusal of my Different Publications. Two Incidents. Documentary Part" (1929).

Stead, D. G., Sydney.—"The Rabbit Menace in New South Wales" (Published by the Department of Agriculture, N.S.W.) (Sydney, 1928).

Veitch, R., B.Sc., F.E.S., Brisbane, Queensland (donor).—"Pests and Diseases of Queensland Fruits and Vegetables" by R. Veitch and J. H. Simmonds (Publication of Department of Agriculture and Stock, Division of Entomology and Plant Pathology) (1929).

LIST OF MEMBERS, 1929.

Ordinary Members.

1927 *Albert, Michel François, "Boomerang", Elizabeth Bay, Sydney.
1905 Allen, Edmund, c/o Chief Engineer for Railways, Brisbane, Q.
1906 Anderson, Charles, M.A., D.Sc., Australian Museum, College Street, Sydney.
1922 Anderson, Robert Henry, B.Sc.Agr., Botanic Gardens, Sydney.
1899 Andrews, Ernest Clayton, B.A., F.G.S., Geological Survey, Department of Mines, Sydney.
1929 Angell, Herbert Raleigh, Ph.D., Council for Scientific and Industrial Research, c/o University of Sydney, Sydney.
1927 Armstrong, Jack Walter French, "Callubri", Nyngan, N.S.W.
1912 Aurousseau, Marcel, B.Sc.

1913 Badham, Charles, M.B., Ch.M., B.Sc., Bureau of Microbiology, 93 Macquarie Street, Sydney.
1888 Baker, Richard Thomas, The Crescent, Cheltenham.
1925 Barnard, Colin, M.Sc., Commonwealth Research Station, Merbein, Vic.
1919 Barnett, Marcus Stanley, c/o Colonial Sugar Refining Co., Ltd., O'Connell Street, Sydney.
1907 Benson, Professor William Noel, B.A., D.Sc., F.G.S., University of Otago, Dunedin, N.Z.
1926 Bingham, Mrs. J., B.Sc. (née Hall), Gosford, N.S.W.
1920 Blakely, William Faris, Botanic Gardens, Sydney.
1929 Boardman, William, Australian Museum, College Street, Sydney.
1923 Bone, Walter Henry, 6 Deans Place, Sydney.
1926 Branch, Kenneth James Fergus, B.Sc., 99 North Steyne, Manly.
1912 Breakwell, Ernest, B.A., B.Sc., Department of Education, Box 33A, G.P.O., Sydney.
1927 Bredero, William Adrien Lewis, Box 127, Post Office, Orange, N.S.W.
1912 Brewster, Miss Agnes A., 481 Alfred Street, North Sydney.
1923 Brough, Patrick, M.A., B.Sc., B.Sc.Agr., "Kinross", Billyard Avenue, Wahroonga.
1921 Brown, Horace William, 871 Hay Street, Perth, W.A.
1924 Brown, Miss Ida Alison, B.Sc., Geology Department, The University, Sydney.
1911 Browne, William Rowan, D.Sc., Geology Department, The University, Sydney.
1928 Burgmann, Rev. Ernest Henry, M.A., St. John's Theological College, Morpeth, N.S.W.
1920 Burkitt, Professor Arthur Neville St. George Handcock, M.B., B.Sc., Medical School, The University, Sydney.
1921 Burns, Alexander Noble, Sugar Experiment Station, Mackay, N. Queensland.
1910 Burrell, Harry, 19 Doncaster Avenue, Kensington.
1910 Burrell, Mrs. Harry, 19 Doncaster Avenue, Kensington.
1926 Buzacott, James Hardie, Meringa (private bag), via Cairns, North Queensland.

1901 Campbell, John Honeyford, I.S.O., M.B.E., Royal Mint, Ottawa, Canada.
1927 Campbell, Thomas Graham, "Burrandong", 101 Lauderdale Avenue, Manly.
1905 Carne, Walter Mervyn, Senior Plant Pathologist, Division of Economic Botany, Council for Scientific and Industrial Research, c/o Department of Agriculture, Perth, W.A.
1890 Carson, Duncan, c/o Winchcombe, Carson, Ltd., Bridge Street, Sydney.
1903 Carter, Herbert James, B.A., F.E.S., "Garrawillah", Kintore Street, Wahroonga.
1899 Cheel, Edwin, Botanic Gardens, Sydney.
1924 Chisholm, Edwin Claud, M.B., Ch.M., Comboyne, N.S.W.
1901 Cleland, Professor John Burton, M.D., Ch.M., The University, Adelaide, S.A.
1920 Cooper, Mrs. A. G. S., B.Sc. (née Henry), Ogilvie Street, Denman, N.S.W.

* Life Member.

1908 Cotton, Professor Leo Arthur, M.A., D.Sc., Geology Department, The University, Sydney.
1928 Craft, Frank Alfred, "Kyla", 24 Fourth Street, Ashbury.
1900 Crago, William Henry, M.D., 185 Macquarie Street, Sydney.
1925 Cunningham, Gordon Herriot, Department of Agriculture, Fields Division, Plant Research Station, P.O. Box 240, Palmerston North, N.Z.

1929 Dakin, Professor William John, D.Sc., Department of Zoology, The University, Sydney.
1885 David, Sir Tannatt William Edgeworth, K.B.E., C.M.G., D.S.O., M.A., D.Sc., F.R.S., Burdett Street, Hornsby.
1925 de Beuzeville, Wilfred Alexander Watt, J.P., Beecroft, N.S.W.
1929 Deane, Cedric, A.M.I.E.Aust., "Cloyne", 9 State Street, Malvern, Victoria.
1928 Dickson, Bertram Thomas, B.A., Ph.D., Division of Economic Botany, Canberra.
1881 Dixson, Thomas Storie, M.B., Ch.M., 215 Macquarie Street, Sydney.
1927 *Dixson, William, "Merridong", Gordon Road, Killara.
1921 Dodd, Alan Parkhurst, Prickly Pear Laboratory, Sherwood, Brisbane, Q.
1926 Dumigan, Edward Jarrett, Boys' State School, Toowoomba North, Toowoomba, Queensland.
1928 Durrell, Miss Eileen Leys, B.Sc., 345 Bridge Street, Drummoyne.
1920 Dwyer, Rt. Rev. Joseph Wilfrid, Bishop of Wagga, Wagga Wagga, N.S.W.

1914 Enright, Walter John, B.A., West Maitland, N.S.W.

1908 Flynn, Professor Theodore Thomson, D.Sc., University of Tasmania, Hobart, Tasmania.
1927 Francis, William Douglas, Botanic Gardens, Brisbane, Queensland.
1911 Froggatt, John Lewis, B.Sc., Department of Agriculture, Rabaul, New Guinea.
1886 Froggatt, Walter Wilson, F.L.S., Young Street, Croydon.
1920 Furst, Herbert Charles.

1927 Garde, Miss Mary Lee, "Wavertree", Kurraba Road, Neutral Bay.
1912 Goldfinch, Gilbert M., "Lyndhurst", Salisbury Road, Rose Bay.
1899 Grant, Robert, 24 Edward Street, Woollahra.
1923 Gray, Archibald James, "Glendyne", Augusta Street, Concord.
1911 Greenwood, William Frederick Neville, F.L.S., F.E.S., c/o Colonial Sugar Refining Co., Ltd., Lautoka, Fiji.
1910 Griffiths, Edward, B.Sc., Department of Agriculture, 136 Lower George Street, Sydney.
1901 Gurney, William Butler, B.Sc., F.E.S., Department of Agriculture, George Street North, Sydney.

1911 Hacker, Henry, F.E.S., Queensland Museum, Bowen Park, Brisbane, Q.
1925 Hale, Herbert Matthew, South Australian Museum, Adelaide, S.A.
1909 Hall, Edwin Cuthbert, M.D., Ch.M., George Street, Parramatta.
1919 Hall, Leslie Lionel, "Haldor", Drumalbyn Road, Bellevue Hill.
1897 Halligan, Gerald H., F.G.S., "Uplands", Station Street, Pymble.
1885 Hamilton, Alexander Greenlaw, "Tanandra", Hercules Street, Chatswood.
1928 Hamilton, Edgar Alexander, 16 Hercules Street, Chatswood.
1922 Hardwick, Frederick George, B.D.S., D.D.Sc., "Wyoming", 175 Macquarie Street, Sydney.
1917 Hardy, G. H. Hurlstone, The University, Brisbane, Q.
1911 Haviland, The Venerable Archdeacon F. E., St. Stephen's Rectory, Portland, N.S.W.
1909 Henry, Max, D.S.O., M.R.C.V.S., B.V.Sc., Coram Cottage, Essex Street, Epping.
1913 Hill, Gerald F., Council for Scientific and Industrial Research, Division of Economic Entomology, No. 12, Melbourne Buildings, Canberra, F.C.T.
1907 Hull, Arthur Francis Basset, Box 704, G.P.O., Sydney.
1892 Hynes, Miss Sarah, B.A., "Isis", Soudan Street, Randwick.

1912 Irby, Llewellyn George, Forestry Department, Hobart, Tasmania.

* Life Member.

1912 Jackson, Sidney William, M.R.A.O.U., Belltrees, via Scone, N.S.W.
1917 Jacobs, Ernest Godfried, "Cambria", 106 Bland Street, Ashfield.
1907 Johnston, Professor Thomas Harvey, M.A., D.Sc., F.L.S., The University, Adelaide, S.A.

1924 Kinghorn, James Roy, Australian Museum, College Street, Sydney.

1923 Lawson, Augustus Albert, 9 Wilmot Street, Sydney.
1892 Lea, Arthur M., F.E.S., 241 Young Street, Unley, Adelaide, S.A.
1915 Le Plastrier, Miss Constance Emily Mary, "Carinyah", Provincial Road, Lindfield.
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1905 Mawson, Sir Douglas, D.Sc., B.E., F.R.S., The University, Adelaide, S.A.
1919 McCarthy, Timothy, Department of Agriculture, George Street North, Sydney.
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1927 McHugh, Miss Mary Virgilius, St. Vincent's College, Potts Point, Sydney.
1917 McKeown, Keith Collingwood, Australian Museum, College Street, Sydney.
1927 McKie, Rev. Ernest Norman, B.A., The Manse, Guyra, N.S.W.
1919 McLuckie, John, M.A., D.Sc., Botany Department, The University, Sydney.
1925 McNeill, Francis Alexander, Australian Museum, College Street, Sydney.
1925 Mitchell, Miss Dora Enid, B.Sc., "Wilga", Bradley Street, Goulburn.
1926 Mungomery, Reginald William, c/o Sugar Experiment Station, Bundaberg, Queensland.
1922 Murray, Patrick Desmond Fitzgerald, D.Sc., Zoology Department, The University, Sydney.
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1927 Oke, Charles George, 56 Chaucer Street, St. Kilda, Victoria.
1910 Oliver, Walter Reginald Brook, F.L.S., F.Z.S., Dominion Museum, Wellington, N.Z.
1927 Osborn, Professor Theodore George Bentley, D.Sc., F.L.S., Department of Botany, The University, Sydney.
1921 Osborne, George Davenport, D.Sc., Geology Department, The University, Sydney.

1922 Perkins, Frederick Athol, B.Sc.Agr., Biology Department, University of Queensland, Brisbane, Q.
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1918 Priestley, Professor Henry, M.D., Ch.M., B.Sc., Medical School, The University, Sydney.
1924 Pritchard, Denis Adrian, M.B., Ch.M., B.Sc., H.M.A.S. Penguin, G.P.O., Sydney.
1910 Pulleine, Robert Henry, M.B., Ch.M., 163 North Terrace, Adelaide, S.A.

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1927 Richardson, Keith Clifford, B.Sc., Zoology Department, The University, Sydney.
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1887 Sloane, Thomas G., F.E.S., Moorilla, Young, N.S.W.
1909 Smith, G. P. Darnell, D.Sc., F.I.C., F.C.S., Botanic Gardens, Sydney.
1928 Smith, Jacob Harold, M.Sc., N.D.A., Court House, Cairns, N. Queensland.
1928 Smith, Thomas Hodge, Australian Museum, College Street, Sydney.
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1905 Stokes, Edward Sutherland, M.B., Ch.M., Metropolitan Water, Sewerage and Drainage Board, 341 Pitt Street, Sydney.
1911 *Sulman, Miss Florence, "Burrangong", McMahon's Point.
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1926 Taylor, Professor Thomas Griffith, D.Sc., The University of Chicago, Chicago, Ill., U.S.A.
1904 Tillyard, Robin John, M.A., D.Sc., F.R.S., F.L.S., F.E.S., C.M.Z.S., Chief Commonwealth Entomologist, Canberra, F.C.T.
1921 *Troughton, Ellis Le Geyt, Australian Museum, College Street, Sydney.
1902 Turner, A. Jefferis, M.D., F.E.S., Wickham Terrace, Brisbane, Q.
1904 Turner, Rowland E., F.Z.S., F.E.S., "Glen Gordon", Mostyn Road, Colwyn Bay, North Wales, Great Britain.

1917 Veitch, Robert, B.Sc., F.E.S., Department of Agriculture, Brisbane, Queensland.

1900 Walker, Commander John James, M.A., F.L.S., F.E.S., R.N., "Aorangi", Lonsdale Road, Summertown, Oxford, England.
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1926 Waterer, Arthur S., "Cisco", 6 Everton Street, Hamilton, Newcastle, N.S.W.
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1927 Waterhouse, Walter Lawry, D.Sc.Agr., "Hazelmere", Chelmsford Avenue, Roseville.
1911 Watt, Professor Robert Dickie, M.A., B.Sc., University of Sydney.
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1925 Wright, Fred, c/o Messrs. Elliott Bros., Ltd., O'Connell Street, Sydney.
1929 Wright, George Henry, H.D.A., Public School, Barellan, N.S.W.
1910 Wymark, Frederick, 89 Castlereagh Street, Sydney.

Honorary Members.

1923 Hill, Professor J. P., Institute of Anatomy, University of London, University College, Gower Street, London, W.C.1, England.

* Life Member.

1923 Wilson, Professor J. T., LL.D., M.B., Ch.M., F.R.S., Department of Anatomy, the New Museums, Cambridge, England.

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1888 Bale, W. M., F.R.M.S., 63 Walpole Street, Kew, Melbourne, Victoria.
1902 Broom, Robert, M.D., D.Sc., F.R.S., 13 Somerset Street, Grahamstown, South Africa.
1902 McAlpine, D., c/o Bank of New South Wales, Leitchville, Victoria.
1902 Meyrick, Edward, B.A., F.R.S., F.Z.S., Thornhanger, Marlborough, Wilts, England.

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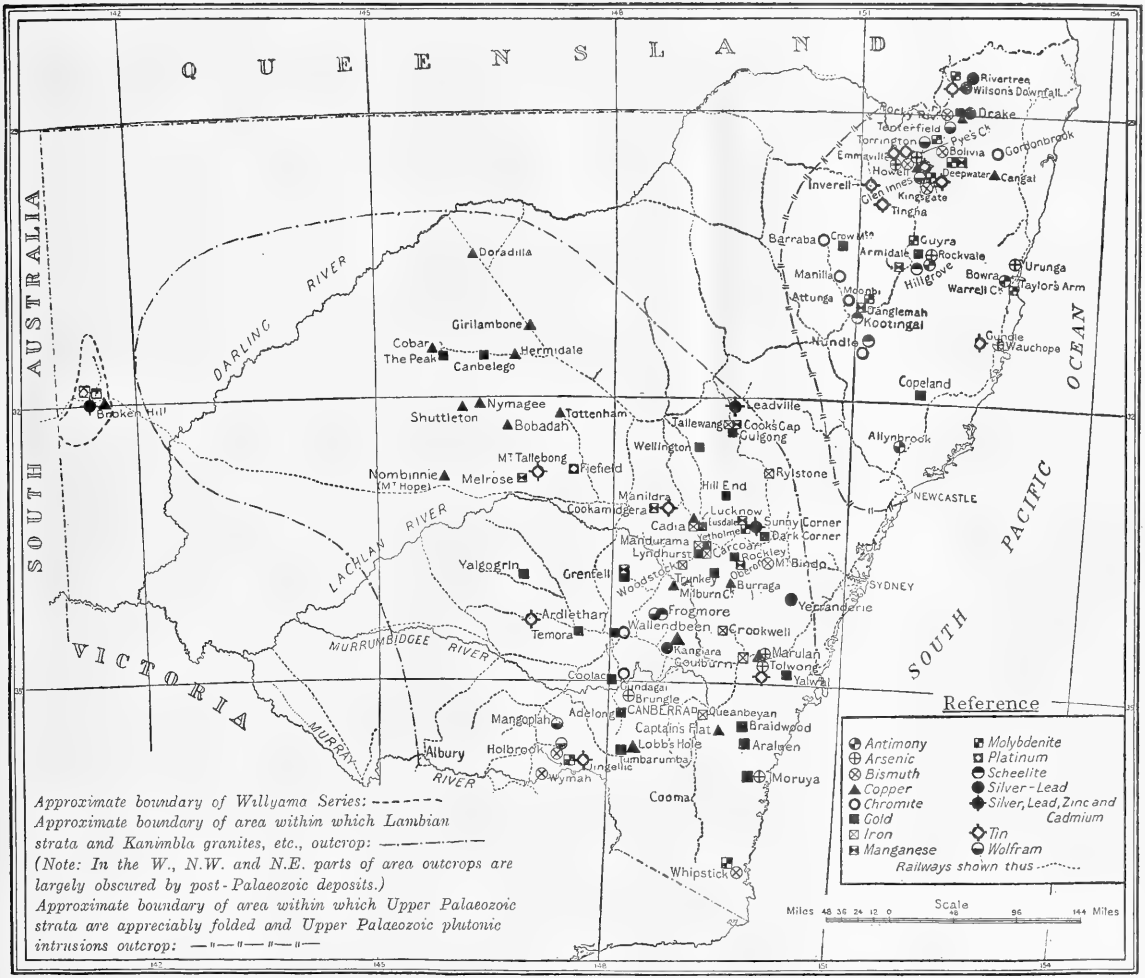

QUEENSLAND
SOUTH AUSTRALIA
VICTORIA
NEW SOUTH WALES
SOUTH PACIFIC OCEAN
DARLING RIVER
LACHLAN RIVER
MURRUMBIDGEE RIVER
MURRAY RIVER
Rivertree
Wilson's Downfall
Drake
Tapperfield
Torrington
Bolivia
Gordonbrook
Emmaville
Howell
Deepwater
Cangai
Inverell
Glen Innes
Kingsgate
Tingha
Barraba
Crow Nest
Guyra
Armidale
Rockvale
Hillgrove
Manilla
Bowra
Warrell Ck
Urunga
Taylor's Arm
Attunga
Moonbi
Danglemah
Kootingal
Nundle
Gundle
Wauchope
Copeland
Doradilla
Girilambone
Cobar
The Peak
Hermidale
Canbelego
Broken Hill
Nymagee
Shuttleton
Tottenham
Bobadah
Leadville
Tallawang
Cooke's Cap
Gulgong
Wellington
Allynbrook
Mt Tallebong
Fiefield
Nombinnie
(Mt Hope)
Melrose
Rylstone
Manildra
Hill End
Cookamidgera
Lucknow
Cadia
Lusdale
Yetholme
Sunny Corner
Dark Corner
Mandurama
Lyndhurst
Carcoar
Rockley
Mt Bindo
Yalgogrin
Grenfell
Woods Ck
Trunkey
Burraga
Milburn Ck
Yerranderie
Ardlethan
Temora
Frogmore
Wallendbeen
Crookwell
Kangiara
Goulburn
Marulan
Tolwong
Yalwal
Coolac
Tarcutta
Hondagai
Brungle
CANBERRA
Queanbeyan
Mangoplah
Adelong
Captain's Flat
Braidwood
Lobb's Hole
Araluen
Albury
Holbrook
Tumbarumba
Jingellic
Wymah
Moruya
Cooma
Whipstick
NEWCASTLE
SYDNEY
Reference
Antimony
Arsenic
Bismuth
Copper
Chromite
Gold
Iron
Manganese
Molybdenite
Platinum
Scheelite
Silver-Lead
Silver, Lead, Zinc and Cadmium
Tin
Wolfram
Railways shown thus
Scale
Miles 48 36 24 12 0 48 96 144 Miles
Approximate boundary of Willyama Series:
Approximate boundary of area within which Lambian strata and Kanimbla granites, etc., outcrop:
(Note: In the W., N.W. and N.E. parts of area outcrops are largely obscured by post-Palaeozoic deposits.)
Approximate boundary of area within which Upper Palaeozoic strata are appreciably folded and Upper Palaeozoic plutonic intrusions outcrop:

AUSTRALIAN PYRGOTIDAE (DIPTERA).

By Mario Bezzi,* Italy.
With an Appendix by J. R. Malloch.

(Fourteen Text-figures.)

[Read 27th March, 1929.]

The Pyrgotidae, formerly regarded as a subfamily of the Ortalidae, are now separated as a distinct family of the Ortalidiformes series, or of the Tephritomorphae group. This last group is distinguished chiefly by the divergent, never convergent, postvertical bristles, and the strongly chitinized, and well developed, ovipositor of the females.

The principal characters of the Pyrgotidae are as follows: Ocelli often lacking; lunule not exposed; prelabrum small; no propleural bristle, but prothoracic hairs or bristles usually present; only three supra-alar bristles; squamulae small; penis spiral; tibiae without preapical dorsal bristle; first longitudinal wing vein hairy or bristly; third vein as a rule bare at base; lower angle of anal cell acute, and usually produced. The most conspicuous feature is the exceptionally developed ovipositor, which is conical or cylindrical, greatly swollen at base, very often as long as the remainder of abdomen, which in the female has six visible segments.

The Pyrgotidae are conspicuous flies, of large or medium size, rarely small; they are always of pale yellowish colour, or reddish, and very often have variegated wings. These pale colours are certainly related to the nocturnal habits of most of the species. Specimens caught at light are frequently met with in collections, as has been several times recorded, and Mr. H. K. Munro of East London, Transvaal, informs me that in South Africa Pyrgotidae are almost exclusively taken at light. The reduction of the eyes and lack of ocelli in many species are perhaps due to these habits.

The food of the adult flies is unknown, but they certainly do not feed on flowers; some species may be predacious, like the equally yellow and nocturnal *Bengalia*, etc., but they have more fleshy soft proboscides.

Where the larvae are known they are endoparasitic upon lamellicorn beetles of nocturnal habits, first discovered in North America, where they parasitize the genus *Phyllophaga*, and more recently they have been recorded as attacking the Javanese species *Adoretus compressus*, by Dr. de Meijere. The well developed, and often tuberculate, ovipositor is apparently adapted to the peculiar method of oviposition, or possibly of larviposition, in the host, and the coxae sometimes bear tufts of small spines, similar to those present in some Tachinidae.

The Pyrgotidae are evidently allied to the Conopidae, as evidenced by the shape of the head, abdomen, and legs, etc., and by the endophagous habits of the larvae, living in the bodies of living insects, those of the former in Coleoptera, and those of the latter in Hymenoptera. This affinity was pointed out by de Meijere, and more recently by Malloch.

---

* At the time of Professor Bezzi's death the manuscript of this paper was not in shape to send to the press and it was prepared by Mr. J. R. Malloch so that the work of the author might not be lost.

The family is not a large one in point of number of species, but is present in all the zoological regions. The flies are very rare in Europe (I have never met with them in more than 30 years' collecting), but they are rather frequently met with in North America, and seem to be rather plentiful in tropical and subtropical countries. I present below a complete list of the described species, but there are a number of new species (14) not in this list, which I have included in a paper dealing with the Ethiopian fauna.

List of Described Species.

1. *Toxura microps* Hendel, 1914, Sydney, N.S.W.
2. „ *longipalpis* Hendel, 1908, Australia.
3. „ *maculipennis* Macquart, 1850, Tasmania.
4. „ *angustifrons* Hendel, 1914, Queensland.
5. „ *variegata* Hendel, 1908, Australia.
6. *Epicerella guttipennis* Macquart, 1850, Tasmania.
7. „ *miliacea* Hendel, 1914, Queensland.
8. „ *punctulata* Hendel, 1914, W. Australia.
9. *Acropyrgota flavescens* Hendel, 1914, Australia.
10. *Trichellopsis tipuloides* Hendel, 1914, S. Africa.
11. „ *muiri* Hendel, 1914, S. Africa.
12. „ *tephritoides* Hendel, 1914, Cape of Good Hope.
13. *Tephritopyrgota vesicatoria* Hendel, E. Africa.
14. „ *stylata* Hendel, 1914, E. Africa.
15. „ *belzebuth*, Hendel, 1914, E. Africa.
16. „ *carbonaria* Hendel, 1914, S. Africa.
17. „ *nubilipennis* van der Wulp, 1885, Central Africa.
18. „ *passerina* Hendel, 1914, S. Africa.
19. „ *abjecta* Adams, 1905, S. Africa.
20. „ *hirsuta* Hendel, 1914, S. Africa.
21. „ *tenuis* Hendel, 1914, S. Africa.
22. „ ? *microcera* Portchinsky, 1892, Amur.
23. „ ? *ferruginea* Walker, 1853, India.
24. *Pyrgota valida* Harris, 1867, N. America.
25. „ *maculipennis* Macquart, 1846, N. America.
26. „ *undata* Wiedemann, 1830, N. America.
27. „ *pterophorina* Gerstaecker, 1860, N. America.
28. „ *vespertilio* Gerstaecker, 1860, N. America.
29. „ *filiola* Loew, 1876, N. America.
30. „ *chagnoni* Johnson, 1900, N. America.
31. „ *fenestrata* Macquart, 1850, America.

31*a*. „ *lugens* van der Wulp, 1898, Guatemala.

32. „ *longipes* Hendel, 1908, Brazil.
33. *Teretrura flaveola* Bigot, 1885, Chile.
34. *Adapsilia coarctata* Waga, 1842, Europe.
35. „ *wagae* Bigot, 1880, Persia, Caucasus.
36. „ *fusca* Hendel, 1914, Japan.
37. „ *luteola* Coquillett, 1898, Japan.
38. „ *omorii* Matsumura, 1916, Japan.
39. „ *flavopilosa* Hendel, 1914, Japan.

40. *Adapsilia vulpina* Hendel, 1914, Sikkim.
41. „ *armipes* Hendel, 1914, Sikkim.
42. „ *opaca* Bezzi, 1914, Sikkim.
43. „ *nocturna* Bezzi, 1914, Sikkim.
44. „ *brahma* Hendel, 1914, S. India.
45. „ *scutellata* Hendel, 1914, N.W. India.
46. „ *trinotata* de Meijere, 1914, Java.
47. „ *magnicornis* Hendel, 1914, Ceylon.
48. „ *amplipennis* Bezzi, 1914, China.
49. „ *angustifrons* Bezzi, 1914, India.
50. „ *longina* Hendel, 1914, E. Africa.
51. „ *caffra* Hendel, 1914, Natal.
52. „ *ypsilon* Hendel, 1914, Sierra Leone.
53. „ *latipennis* Walker, 1849, W. Africa.
54. *Apyrgota scioida* Hendel, 1908, Molucca.
55. „ *pictiventris* Hendel, 1914, Ceylon, India.
56. „ *unicolor* Hendel, 1914, Ceylon.
57. „ *pubiseta* Hendel, 1914, Oriental Region.
58. „ *alienata* Walker, 1861, Ceram.
59. „ *marshalli* Hendel, 1914, Nyasaland.
60. „ ? *personata* Lutz and Lima, 1918, Brazil.
61. *Leptopyrgota amplipennis* Hendel, 1914, Bolivia.
62. „ *sahlbergiana* Frey, 1918, Brazil.
63. *Hypotyphla loewi* Hendel, 1908, S. Africa.
64. *Campylocera gracilis* Hendel, 1914, W. Africa.
65. „ *caudata* Hendel, 1914, W. Africa. [As a *Hypotyphla*.]
66. „ *piceiventris* Hendel, 1914, E. Africa.
67. „ *pleuralis* Hendel, 1914, E. Africa.
68. „ *myopa* Hendel, 1914, Nyasaland.
69. „ *nigriventris* Hendel, 1914, S. Africa.
70. „ *unicolor* Becker, 1909, E. Africa.
71. „ *maculifer* Hendel, 1914, S. Africa.
72. „ *angustigenis* Hendel, 1914, S. Africa.
73. „ *latigenis* Hendel, 1914, E. Africa.
74. „ *oculata* Hendel, 1914, E. Africa.
75. „ *ferruginea* Macquart, 1843, S. Africa.
76. „ *robusta* van der Wulp, 1880, Java, Sumatra.
77. „ *longicornis* van der Wulp, 1885, Java.
78. „ *myiopina* van der Wulp, 1880, Java.
79. „ *fuscipes* van der Wulp, 1885, Java.
80. „ *thoracalis* Hendel, 1914, Philippines.
81. „ *rufina* Bezzi, 1917, Philippines.
82. „ *brevicornis* Hendel, 1908, New Guinea.
83. *Prosyrogaster chelionotus* Rondani, 1875, Borneo.
84. *Diasteneura laticeps* Hendel, 1908, S. Africa.
85. *Tylotrypes immsi* Bezzi, 1914, India.
86. *Eumorphomyia tripunctata* Doleschall, 1859, Amboina.
87. *Geloemyia stylata* Hendel, 1908, Tonkin.
88. *Toxopyrgota inclinata* Hendel, 1917, E. Africa.

As will be seen from the preceding enumeration, the genera have a clearly limited geographical distribution; only one genus is common to the Old and New Worlds, that is *Apyrgota*, but the neotropical species (*personata*) may belong to a distinct genus. The few genera with a wide range are *Pyrgota* (nearctic and neotropical) and *Adapsilia* and *Campylocera* (all regions of the Old World).

The Australian Pyrgotidae are very peculiar. There are amongst them forms with ocelli and with broad pterostigma (*Toxura* and *Epicerella*), and forms with pointed third antennal segment (both the above-named genera and *Acropyrgota*). To these forms are added here some very aberrant species which are closely allied to the Myopine flies.*

The material for the present monograph was received from the late Dr. E. W. Ferguson, Dr. J. F. Illingworth, and Mr. G. F. Hill, to whom my thanks are due.

The Australian genera may be distinguished as in the following key.

Key to the Genera.

1 (6). Ocelli well developed, and three in number; ocellar bristles lacking or rudimentary; third antennal segment usually with a sharp point at apex; pterostigma broad and long.

2 (3). Facial keel broad and flat, the antennae being concealed in the facial grooves; sternopleural and pteropleural bristles not distinct; mid tibiae without distinct spurs ..... 1. *Maenomenus*, nov. gen.

3 (2). Facial keel narrow and sharp, the antennae being free and exserted; sternopleural and pteropleural bristles well developed, sometimes very strong; mid tibiae with the usual terminal spurs.

4 (5). Three notopleural bristles present (1:2); basal abdominal segment not longer than second; face not prominent below the apices of antennae; ovipositor clothed with slender sparse hairs; wings banded or entirely hyaline, always destitute of small clear spots ..... 2. *Toxura* Macquart

5 (4). Only two notopleurals present (1:1); basal abdominal segment at least twice as long as second; face distinctly produced just below apices of antennae; ovipositor clothed with dense rigid hairs; wings with more or less numerous clear spots ..... 3. *Epicerella* Macquart

6 (1). Ocelli entirely lacking, but the ocellar bristles more or less developed; pterostigma very narrow, and usually short.

7 (12). Proboscis short and simple, shorter than the palpi; frons in both sexes as broad as, or only a little narrower than, one eye; apical section of fourth vein curved downward at end, the first posterior cell being thus widened at apex.

8 (11). Wings with the costal vein extending to apex of fourth vein, the latter complete to margin of wing; second vein with a strong stump.

9 (10). Third antennal segment pointed at apex; vertex without transverse keel; discal cell narrowed at base ..... 4. *Acropyrgota* Hendel

10 (9). Third antennal segment rounded at apex; vertex with a prominent transverse keel; discal cell not narrowed at base ..... 5. *Adapsilia* Waga

11 (8). Costal vein ending at third vein, and the fourth evanescent apically, or at least less distinct apically than basally; second vein without stump ..... 6. *Campylocera* Macquart

12 (7). Proboscis longer than the palpi, and distinctly geniculated; frons of the male much narrower than one eye; apical section of fourth vein straight, the first posterior cell with parallel sides ..... 7. *Prodalmannia*, nov. gen.

1. Maenomenus, nov. gen.

This genus is the most aberrant of those provided with distinct ocelli; all the three genera with ocelli are peculiar to Australia, and are evidently the most ancestral forms in the entire family. This genus is likewise aberrant in possessing

* In this connection it may be mentioned that in Krober's monograph of the Conopidae there are no Myopinae, Dalmanniinae, or Stylogasterinae, recorded from Australia.

a short basal abdominal segment, a character which it shares with *Toxura*, but differs from that genus, as well as from all others in the family, by lacking the terminal spurs on the mid tibia. The form of the head is very like that of the Myopinae, thus this genus and *Prodalmannia* represent two very evident connecting links between the Conopidae and Pyrgotidae. The general shape of the present genus is also not unlike that of some Chloropidae.

Body slender and elongate, with short bristles and sparse hairs; colour testaceous, with black stripes and spots. Head greatly developed, subquadrate in profile, shaped not unlike that of some Myopinae, occiput convex and rather swollen, with distinct lower swellings. Vertex slightly carinate, but the keel not prominent. Frons equally wide in both sexes, more than twice as wide as one eye, flat, in profile bluntly prominent in front; the middle stripe is extended to the eyes, the parafrontals being distinguishable only on sides of anterior half. Lunule small, concealed. Three well developed and approximated ocelli present. Eyes small, rounded, placed somewhat obliquely, bare, with small facets. Parafacials and peristomalia broad. Antennae short, widely separated at bases, inserted at level of the upper border of the eyes, rather concealed in the facial grooves; second segment with sparse hairs; third segment rounded at apex, without upper terminal point; arista basal, short, bare, thickened at base. Face broad, with a very broad and flat middle keel, the oral grooves widely separated, extending to lower level of eyes; mouth opening long and broad. Palpi dilated at apices, longer than the mouth, nearly bare; proboscis short and simple, concealed in the mouth. Cephalic bristles reduced to a single pair of rather short verticals, the other bristles not distinguishable, but traces of a short orbital on each side; hairs very scarce, even in front of middle stripe. Mesonotum elongate, with the transverse suture broadly interrupted in middle; bristles rather weak, one humeral, two notopleurals, one presutural, two posterior supra-alars, one pair of dorsocentrals, one mesopleural, and the propleural tuft well developed. Scutellum small, short, convex, with four to six marginal bristles. Abdomen slender, parallel-sided, not at all constricted at base, a little longer than thorax; in the male there are five visible segments, and in the female six; basal segment not at all elongated, shorter than the second; male genitalia rounded, not visible from above; ovipositor very long, about as long as entire body, much swollen at base. Legs stouter in the male than in the female, in both sexes nearly bare, with very short hairs even on the femora; mid tibia without distinct apical spurs; preapical bristle present only on fore tibia, but inconspicuous; tibiae not longer than their femora, only those of the hind pair being a little elongate in the female; tarsi short in the male, longer in the female, rather broad at apices. Wings long and narrow; costa produced to apex of fourth vein and nearly bare, even at base. Auxiliary vein thick and entire, ending at an acute angle with costa; first vein ciliated throughout its length, ending beyond middle of wing, but slightly before level of inner cross-vein, the latter placed very close to the outer cross-vein; second vein straight and without stump; third vein straight, bare at base, ending near the tip of wing; apical section of fourth vein complete, slightly curved to the middle; discal cell long, its lower terminal angle being very near the hind border of the wing; outer cross-vein straight, perpendicular, considerably longer than its distance from inner one; anal cell broad outwardly, its lower angle small, acute, distinctly but not very much produced; sixth vein strong, extending to margin of wing, subobsolete at apex. Axillary lobe and alula well developed, much longer than broad; spurious axillary vein long.

Type, the following species.

MAENOMENUS ENSIFER, n. sp.

A strikingly characterized species, with a brown costal border and a broadly infuscated outer cross-vein to the wings.

Type, male, and allotype, in Health Dept. collection, the male from Manly, 6.xii.1923, the female from Sydney, 20.xi.1921, E. W. Ferguson.

Male and female.—Length of body and wing, 7 mm., of ovipositor, 6 mm.

Head entirely testaceous, opaque, shining only on sides of occiput and near the vertex. The occiput has four oblique black stripes above, two on each side, radiating from the centre, but not reaching the sides, the outer ones ending near middle of eyes, the inner ones near upper angle of eyes. There is also a rounded black ocellar spot. Frons dull reddish, with a narrow black middle line extending from the ocellar spot to lunule; parafacials and cheeks reddish, unspotted, with sericeous reflections. Antennae entirely reddish-yellow. Face reddish, with a broad deep black rounded spot on the middle of supraoral plate. Palpi and proboscis yellowish. Vertical bristles black; the very sparse hairs are dark, but on lower part of head there are a few longer pale hairs. Mesonotum testaceous, slightly shining, with four narrow black stripes which are abbreviated in front and confluent behind, but the two middle ones are often linear or wanting in the male; a narrow black stripe runs along the notopleural suture from the humeri to the base of wing, and just above the root of the wing there is also a short black stripe, while behind the root there is a rounded black spot. Pleura more yellowish, and rather shining; a narrow black stripe running parallel to the notopleural suture and extending from the propleural tuft to the middle of mesopleura; sternopleura shining black; a rounded shining black hypopleural spot, and below this a deep black spot just above the hind coxa; mesophragma shining black, with a reddish line along the middle in the male. Bristles black; hairs black, very sparse and short, even on the pleura. Scutellum shining reddish, with two black stripes above in continuation of those on mesonotum. Halteres pale yellowish. Abdomen testaceous, rather shining, with two narrow parallel black stripes on middle of back extending from the second segment to the tip in the female, but present only on second and third segment in the male; in addition the side margins are each marked with a narrow line; venter reddish-yellow, unspotted; hairs and bristles black. Male genitalia shining reddish; ovipositor shining black, quite bare. Legs entirely yellowish to apices of tarsi, unspotted; the very short and sparse hairs are all black, being longer and more numerous in the male. Wings whitish hyaline, with black, rather thick, veins which are reddish towards the base. The brown pattern is formed by a broad costal border, which does not extend below the third vein except at apex, where it reaches the middle of the first posterior cell; this dark border is more yellowish in the costal cells and along the submarginal cell, but is darker at the apex; the stigma is black in the male and pale in the female. In addition the outer cross-vein is broadly margined with fuscous, forming an oblique band extending from hind margin of wing to the fourth vein. The inner cross-vein is not, or very slightly, margined with fuscous, and is situated near the apex of discal cell, being about as long as, or longer than, its distance from hind one.

2. TOXURA Macquart, 1850.

This is a typical Australian genus. It is very distinct from all the other known genera of the family on account of the three notopleural bristles, the two posterior ones being of about equal size and placed one above the other; in addition the

short basal segment of abdomen is also characteristic. I have seen only two species, and therefore I can not say if these characters are also present in all the known species; but as the three notopleurals were specifically mentioned by Hendel in his generic description in 1908, I think that the character is common to all the species described by him, notwithstanding that he differentiated the genus from *Epicerella* only by the wing pattern in his paper in 1914.

The species known to me may be distinguished as follows:

1 (4). Wings wholly hyaline, quite unspotted.
2 (3). No postvertical bristles; cheek broader than the vertical diameter of eye; wings greyish only at base, and yellowish near costa ..... *microps* Hendel
3 (2). Postvertical bristles present; cheek only one-half as broad as the vertical diameter of eye; wings wholly yellowish, more intensely so on costa .... *longipalpis* Hendel
4 (1). Wings with fuscous bands or with fuscous spots.
5 (6). Frons only one-half as broad as one eye; no postverticals; antennae black; wings banded, with two fuscous bands and two or three hyaline spots .... *angustifrons* Hendel
6 (5). Frons as broad as, or broader than, one eye.
7 (10). Wings with two broad dark bands, which are not interrupted by hyaline spots.
8 (9). No postverticals; third antennal segment reddish-yellow; mesonotum pale brown; intermediate pair of scutellar bristles sometimes wanting; only one strong mesopleural bristle present ..... *variegata* Hendel
9 (8). Postverticals present; third antennal segment black; mesonotum largely black; scutellum with six strong bristles; two strong mesopleurals present .... *robusta*, n. sp.
10 (7). Wings not banded, with fuscous spots only.
11 (12). Inner cross-vein not margined with fuscous ..... *maculipennis* Macquart
12 (11). Inner cross-vein broadly margined with fuscous ..... *discoidalis*, n. sp.

Toxura microps Hendel.

Arch. f. Naturgesch., 1914, p. 115, fig. 15.

A smallish species (5 mm.), very distinct from the other known species on account of its very small eyes.

Described in both sexes from Sydney, N.S.W., and from Moreton Bay. Types in the British Museum; not seen.

Toxura longipalpis Hendel.

Wien. entom. Zeit., 1908, p. 147; *Gen. Ins.*, 1908, pl. 1, fig. 24, 25.

A little larger than the preceding species (7·5 mm.), and distinguished by the larger eyes and long palpi.

Described from the female. Locality, Sydney. Type in Vienna Museum. Not seen.

Toxura angustifrons Hendel.

Arch. f. Naturgesch., 1914, p. 116.

Close to the following species and with a similar wing pattern, but distinguished by the narrower frons, and the black antennae. The fuscous bands on the wings have some hyaline spots in them as in *Epicerella plagiata*, and the species may belong to that genus.

Described from the female only. Locality Burpengary, S. Queensland. Type in the British Museum. Not seen.

Toxura variegata Hendel.

Wien entom. Zeit., 1908, p. 148; *Gen. Ins.*, 1908, pl. 1, fig. 22, 23.

A very distinct species on account of the two broad dark bands on the wing, which are not at all interrupted by hyaline spots; antennae reddish.

Described from a male taken in North Queensland. Type in Vienna Museum. I have seen one male specimen from New South Wales, Overland Corner, December 2, 1913 (E. W. Ferguson). This specimen has only four scutellar bristles, the intermediate pair being indistinguishable. In addition the ocellar bristles are not evident, the eyes seem to be more rounded, but in other respects it agrees with the description.

Toxura robusta, n. sp.

Closely related to the preceding species, but more robust, much darker in colour, and having better developed bristles.

Type male, a specimen from Victoria, Warburton, January 13, 1924 (F. E. Wilson).

Male.—Length of body and wing about 10 mm. Head as described and figured by Hendel for *variegata*. The occiput is, however, darker, being blackened on its upper portion; the chaetotaxy is the same, but there is a well developed pair of postvertical bristles present; the ocellars are short and fine; median frontal stripe very dark reddish-brown, almost blackened on anterior portion; eyes rounded, about as high as long; third antennal segment black, rounded at apex, without prominent acute point; parafacials narrower than in *variegata*, reddish-brown below; peristomalia a little narrower, unspotted, but narrowly reddish-brown along lower border of eyes; supraoral plate shorter, margined with black above; face whitish. Mesonotum almost entirely black on disc, reddish-brown in front, with pale yellowish humeri; notopleural region and supra-alar stripe yellowish; on centre of mesonotum there is a greyish vitta, but there is no distinct division of the black portion into four vittae; pleura reddish or yellowish, with broad blackish-brown patches; the mesopleura is black, with yellowish upper border. Scutellum black above, pale yellowish on sides and below; postscutellum and mesophragma shining reddish-brown. Hairs and bristles black; chaetotaxy as in *marginata*, but better developed, the intermediate pair of scutellar bristles as strong as the others; scutellum more haired above; two strong bristles and a series of bristly hairs on the mesopleura; pteropleural and sternopleural hairs very strong. Halteres pale yellowish. Abdomen dark reddish-brown, the tergites blackened centrally or basally; all the segments of about equal length, only the apical segment being evidently elongated; hairs and bristles black; venter opaque blackish, the dorsum rather shining. Legs as in *variegata*, but all femora more broadly and intensely blackened. Wings with venation and pattern as in *variegata*, the whitish hyaline band between the two dark bands on fore border is broad, and without dark clouds or stripes, and the hind cross-vein is broadly margined with fuscous.

Toxura maculipennis Macquart.

Mem. Soc. Sci. Lille, 1851, p. 263, pl. 26, fig. 18 (p. 289 of reprint).

Distinguished by the simple wing pattern, which consists only of an abbreviated narrow dark band below the stigma extending to the inner cross-vein, and another narrow preapical dark band from costa at apex of second vein extending to middle of apical section of fourth vein.

Described from a female specimen taken in Tasmania. Type in Paris Museum. Not seen.

Urophora testacea Macquart (*l.c.*, 1851, p. 260 (286) pl. 26, fig. 12) seems to be a *Toxura* very like *maculipennis*, differing only in having a black stripe on the

sides of mesonotum, and a somewhat different wing pattern, which latter is, however, of the same type.

TOXURA DISCOIDALIS, n. sp.

Allied to the preceding species, but distinguished from it by having the inner cross-vein of wing broadly margined with fuscous.

Type female, in the Health Dept. collection, from Milson Is., October 31, 1914.

Female.—Length of body, including ovipositor, 10 mm., of wing, 9·5 mm.; wing spread, 22 mm.

Occiput flat above, with less prominent lateral swellings below, reddish on upper half, blackened towards the upper border of eyes and vertex, and pale yellowish below on sides, and there clothed with scattered fine pale hairs. Frons comparatively narrow, distinctly narrower than one eye, and about twice as long as wide; at vertex there is no prominent keel, opaque reddish-brown on central stripe which is clothed with rather long dark hairs, and is whitish-yellow on sides; in profile the frons is protruded in front not more than as far as width of third antennal segment, and on the projecting portion clothed with short dark hairs. Three distinct ocelli present, placed very close together on a small triangle which bears two pairs of short black bristles. Antennae short, reddish, with the third segment darkened; second segment a little shorter than third, with short black hairs, third segment oval, attenuated at apex, but not exactly pointed; arista twice as long as antenna, slender, bare, thickened at base, with distinct basal segment. Face entirely flat, narrower than one eye, not at all prominent above the mouth border, antennal grooves separated by a keel extending to lower margin of eyes, entirely yellowish, shining only in the grooves; parafacials opaque yellowish, narrow, half as wide as third antennal segment, haired only above; peristomalia opaque yellowish, unspotted, bare, about one-third as high as vertical diameter of eye. Eyes bare, oval, their vertical diameter twice as great as their horizontal, the middle anterior facets enlarged. Palpi broad, spatulate, reddish, devoid of bristles and hairs; proboscis shorter than the palpi, dirty yellowish, comparatively small, even the mouth opening being rather small. Bristles black, two pairs of verticals, and some short bristles along the upper eye border; postverticals and ocellars small; two pairs of orbitals which are long and erect, curved outwardly. Thorax shining reddish-brown, with pale yellowish humeri and sides of mesonotum, dorsum clothed with short black pubescence, with faint whitish dust, and with four faint dark vittae. Bristles long and strong, black, one humeral, three notopleurals (1:2), one presutural, one anterior supra-alar, two posterior supra-alars, one dorsocentral, two prescutellars, two mesopleural, one pteropleural, and one sternopleural amongst long rigid hairs; propleural bristles numerous; mesopleura clothed with black hairs. Scutellum reddish, less shining than mesonotum, with short black hairs and six strong bristles. Below the postalar ridge, near the base of wing, there is a small rounded black spot; mesophragma shining reddish-brown; halteres pale yellowish; squamulae whitish, with short fringe of soft pale hairs. Abdomen reddish, slightly shining, with short black pubescence and black bristles at sides and behind; first segment not at all narrowed at base, short, but little longer than second segment; ovipositor about as long as the remainder of abdomen, conical, shining reddish-brown, clothed with very few fine black hairs, and provided below towards the middle with a tuft of six or seven strong short black spines.

Venter blackish, opaque, nearly bare. Legs short and stout, entirely reddish, unspotted; coxae with black bristles; femora with distinct rows of bristles; tibiae simple; apical segment of all tarsi dilated. Wings comparatively narrow and long; auxiliary vein broken at right angles at apex; stigma broad, about three times as long as wide, yellowish, unspotted; second vein straight, devoid of stump; third vein with two or three short bristles at extreme base, its apical section gently curved downward, ending a little before wing tip; costa ending at fourth vein; apical section very fine; last portion of fourth vein complete, regularly curved, the second posterior cell dilated above towards middle; inner cross-vein placed beyond the middle of discal cell; outer cross-vein straight and perpendicular, a little shorter than its distance from inner cross-vein; lower angle of anal cell acute, and considerably produced; sixth vein distinct only at extreme base, subobsolete apically, but extending to margin of wing. The wings are greyish hyaline, a little yellowish at base and along costa; the most conspicuous dark mark is the broad clouding over the inner cross-vein in the middle of the wing; there is a dark spot at base of third vein, a less distinct fuscous cloud in the apices of marginal, sub-marginal, and first posterior cells beyond the outer cross-vein, the latter very faintly infuscated.

3. Epicerella Macquart, 1850.

Hendel, *Gen. Ins.*, Pyrgotinae, 1908, p. 25.

This genus is also characteristic of the Australian fauna. It is less aberrant than the last preceding one, having but two notopleural bristles, and the basal abdominal segment more elongate, and distinctly constricted at base. The third antennal segment may, or may not, be acute at apex. The wings of the several species are as narrow as in *Toxura*, and have a very similar pattern, but always have rounded hyaline spots in the dark portions. The species with the more punctate wings have also the wings very broad. The second wing vein has often a stump, which is absent in all the species of *Toxura*. The facial prominence just below the tips of antennae is also characteristic.

The species may be distinguished as in the following key:

1 (4). Wings comparatively narrow, more banded than spotted; pterostigma fuscous, always destitute of hyaline spots; second vein without stump.
2 (3). Two pairs of dorsocentrals; one upper orbital; wings with an extensive dark pattern, forming distinct fasciae ..... *plagiata*, n. sp.
3 (2). Four pairs of dorsocentrals; two upper orbitals; wings with more reduced dark pattern, not fasciate ..... *setosa*, n. sp.
4 (1). Wings broader, not distinctly banded, with numerous hyaline spots; pterostigma with 1-3 hyaline spots; second vein usually with a stump.
5 (6). Species of very large size (19 mm.), with 10-12 bristles on hind margin of scutellum; third antennal segment pointed at apex; second vein with stump ..... *punctulata* Hendel
6 (5). Smaller species, not more than 11 mm. in length; scutellum with but four bristles.
7 (8). Pterostigma with only one hyaline spot in the middle; second vein without a stump ..... *guttipennis* Macquart
8 (7). Stigma with more than one hyaline spot.
9 (10). Peristomalia barbate; pterostigma with three hyaline spots; third antennal segment attenuated at apex; no yellow hypopleural spot; second vein with a stump ..... *miliacea* Hendel
10 (9). Peristomalia not barbate, or with very few short hairs at border; pterostigma with only two hyaline spots as a rule; third antennal segment parallel-sided, with or without a point at upper apex; a yellow hypopleural spot present.

11 (12). Face without black central stripe; peristomalia unspotted; no postverticals evident; third antennal segment with upper apex pointed; ovipositor with sparse fine hairs ..... *strumosa*, n. sp.
12 (11). Face with a black central stripe; peristomalia with dark spot; postverticals well developed; ovipositor with dense spinose hairs.
13 (14). Third antennal segment with a prominent point at apex above; second wing vein with a stump; ocellars distinct; black costal spots rather distinct .... *maculipennis*, n. sp.
14 (13). Third antennal segment less pointed; no stump on second wing vein; ocellars not distinct; black costal spots less distinct ..... *minor*, n. sp.

EPICERELLA PLAGIATA, n. sp.

Very like *Toxura angustifrons* Hendel, which species may possibly belong to this genus, although the chaetotaxy is described as 'wie bei den anderen Arten', but very readily distinguished by the broader frons.

Type male, in the Health Dept. collection, from Sydney, N.S.W., November 12, 1923.

Male.—Length of body and wing 9 mm. Occiput reddish-brown above, blackened near the vertex and the upper border of the eyes, whitish on the lower swellings, with a few scattered dark hairs. Frons parallel-sided, as broad as one eye, about twice as long as broad, the median stripe reddish-brown, the sides whitish and rather broad, both clothed with short dark hairs, those of the anterior part longer; ocellar spot black, with three approximated ocelli, but without ocellar bristles; an elongated blackish spot at insertion of superior orbital; in profile the frons is produced forward about one-third of the length of the eye, the latter rather small, twice as high as long, with small facets and with the lower margin much above mouth level. Antennae short, entirely reddish, second segment considerably shorter than the third, with a few black hairs, third segment parallel-sided, with the upper terminal angle distinctly produced but not acute; arista bare, twice as long as antenna, inserted basally. Face as broad as one eye, parallel-sided, antennal grooves extending to the lower level of eyes, almost coalescent, the central keel very slight; parafacials a little narrower than third antennal segment; supraoral plate darkened, blackish on sides and at base of central keel. Peristomalia opaque yellowish, unspotted, one-third as broad as the vertical diameter of head, bare, with only a few dark hairs at border; palpi small, not dilated, yellowish, with black bristly hairs; proboscis thick, dirty reddish; cephalic bristles black, two pairs of verticals, the inner pair very long, postverticals very small; only one superior orbital, strong but short, and directed outwardly. Thorax yellowish, slightly shining, dorsum with four broad reddish-brown vittae, the laterals interrupted at the suture and divided posteriorly, the vittae on hind portion thus being six in number; pleura blackish-brown, except a broad pale patch on upper part; pubescence short, blackish, very sparse on pleura; scutellum dark reddish-brown, pale yellowish on sides and below; mesophragma reddish, with a whitish hypopleural spot; bristles black, long and strong, propleural series well developed, one humeral, two notopleurals, one presutural, one anterior supra-alar, two posterior supra-alars, two dorsocentrals, one prescutellar, two mesopleurals, one pteropleural, one sternopleural, and four scutellars, the scutellum without additional hairs. Halteres whitish. Abdomen reddish, yellowish on sides and hind margins of median segments; basal segment constricted at base, and there with a black central vitta, as long as the two following segments combined; fourth segment a little shorter than basal one; pubescence and bristles black. Legs yellowish, with the fore femora blackened outwardly, and the four posterior femora almost entirely

black; pubescence and bristles black, but the latter not strongly developed, forming series only on the posterodorsal surface of fore femora; coxae simple; tarsi short. Wings with the veins as in *Toxura variegata* Hendel, and the pattern very similar, with the black stigma, which is pale yellowish at base; the first dark fascia is broader than in *variegata*, beginning before the stigma, and having in the middle a hyaline streak in the base of the submarginal cell as in *angustifrons* Hendel; the apical fascia has a rounded hyaline spot at apex of the submarginal cell, and two or three similar spots in the first posterior cell; in addition, the second and third posterior cells and the apex of the discoidal cell have 12-14 rounded hyaline spots, which are quite faint; there is also a hyaline spot in the middle of the axillary lobe.

EPICERELLA SETOSA, n. sp.

Very similar to the preceding species, but distinguished by the stronger bristles, and the less well marked wing pattern.

Type female, in the Health Dept. collection; locality, Milson Is., October 31, 1914.

Female.—Length of body and wing 10 mm. Head, its pubescence, and bristles as described for the preceding species; but the frons is distinctly shorter, projecting only as far as width of third antennal segment; the antennae are distinctly longer, with the third segment more rounded at apex; there are two superior orbitals and a pair of short ocellars. Thorax as in preceding species, with the dorsal hairs longer; four dorsocentrals; mesopleura more hairy above. Abdomen opaque reddish, with narrow yellowish hind border to the tergites, and with long black bristles on sides; basal segment as long as the next three combined; ovipositor shining reddish-brown, blackened on sides, broadly conical, clothed with numerous thick black bristles and hairs which are longer ventrally. Legs reddish, the four posterior femora very little darkened; fore pair with a long rigid bristle at base ventrally. Wings as in the preceding species, but with the dark pattern more reduced; the anterior fascia is composed only of the stigma and a spot in the submarginal cell, the inner cross-vein is distinctly clouded, the apical fascia is not extended beyond the third vein; the first posterior cell has four hyaline spots at apex; the remainder is spotted as in the preceding species, but the infuscation is very faint.

N.B.—Curiously enough the wing pattern of the present species is like that of *Toxura discoidalis*, caught at the same time and in the same locality; but the latter has no trace of hyaline spots on the posterior half of the wing; and in addition it has the two characteristic notopleural bristles of *Toxura*, and has the first abdominal segment short.

EPICERELLA PUNCTULATA Hendel.

Archiv. f. Naturgesch., 1914, p. 114, fig. 14.

Very distinct from all the other known species on account of its larger size and of the numerous bristles on hind margin of the scutellum.

Described from the female. Locality, W. Australia. Type in British Museum. Not seen.

EPICERELLA GUTTIPENNIS Macquart.

Mem. Soc. Sci. Lille, 1851, p. 267, pl. 27, fig. 9 (p. 294 of the reprint).

Apparently distinct in having but one hyaline spot in the pterostigma.

Described from Tasmania. Type in Paris Museum. Not seen.

EPICERELLA MILIACEA Hendel.

Archiv. f. Naturgesch., 1914, p. 112, fig. 13.

Distinguished by the peculiar wing pattern, with three hyaline spots in the pterostigma, and the barbate peristomalia.

Described in both sexes from Burpengary and Townsville, Queensland. Types in British Museum. I have seen one male from Mt. Kosciusko, December 7, 1922 (Goldfinch), and one female from Dorrigo, February, 1920 (Wright).

The peristomalia bears along the anterior border a row of long numerous dark hairs, very characteristic of the species, but not recorded in the original description. The third antennal segment is attenuated at apex, but has no prominent upper apical angle. The three hyaline spots in the stigma are typically present, but they may occasionally be absent in one or both wings.

EPICERELLA STRUMOSA, n. sp.

This and the following two species belong to a group of allied species distinguished by their smaller size, the yellow hypopleural spot, and their variegated wings. The present species is distinguished from the other two by the gibbous ovipositor, which is clothed with sparse thin hairs instead of the bristly thick hairs of the other two.

Type female, a poorly preserved specimen in the collection of the Health Dept. Locality, Mosman, Sydney, N.S.W.

Female.—Length of body and wing 7·5 mm. Occiput opaque yellowish, darkened above, and clothed with dark pubescence, lower swellings broad, but not very prominent. Frons parallel-sided, a little narrower than one eye, about twice as long as broad, and not very prominent, in profile projecting about as far as width of third antennal segment, opaque reddish on central stripe, greyish on sides, with a black ocellar spot, on which are three approximated ocelli, the dark hairs are sparse, the central stripe being almost bare; parafacial narrow, linear below, greyish; face short, pale yellowish, with almost coalescent grooves, the median keel being faintly developed above; eye oval, bare, with small facets, twice as high as long, the lower margin almost level with mouth border, supraoral plate very long, narrow, entirely opaque yellowish; peristomalia comparatively narrow, as broad as one-fourth the vertical diameter of eye, unspotted, with short hairs along anterior margin. Antennae short, extending very little below middle of eyes, the basal segments yellowish, second with very sparse and short hairs, third segment reddish, infuscated, about as long as second, with rather prominent upper apical angle; arista a little longer than the antenna, yellowish, bare, thickened basally; palpi and proboscis yellowish, the former with a few black bristly hairs. All cephalic hairs and bristles black, two verticals, the inner much longer than the outer, ocellars and postverticals very short, orbitals apparently rubbed off. Thorax opaque reddish, a little grey dusted on the dorsum, and there with rather indistinct darker vittae; pleura yellowish below the notopleural line, with blackish spots in middle, the hairs very sparse and short even on the pleura, chaetotaxy complete, one humeral, two notopleurals, one presutural, one anterior supra-alar, two posterior supra-alars, two or three dorsocentrals close together, one prescutellar, one mesopleural, one pteropleural, and one sternopleural, all the bristles black; propleural series well developed; scutellum yellowish, with two dark dorsal stripes, almost bare, with four bristles. Mesophragma reddish-brown, slightly shining, on each side with a striking pale yellowish hypopleural spot. Halteres pale yellowish. Abdomen opaque reddish, unspotted, with black pubes-

cence and bristles; first segment longer than all the others combined; ovipositor a little longer than the whole abdomen and broader than it, swollen, gibbous beyond middle, constricted posteriorly, shining reddish, with sparse fine dark hairs above and below. Legs entirely opaque reddish, unspotted, comparatively slender, almost bare, without series of bristles; fore femora below with one rigid bristle near the base; tibiae slender and straight; tarsi long. Wings normal, second vein straight, without stump, third vein bare at base, straight, apical section of fourth vein complete, and curved downward apically; inner cross-vein at middle of discal cell; outer cross-vein straight, long, perpendicular, shorter than its distance from inner; anal cell broad at apex, with the lower apical angle acute, but not much produced. The pattern of wing is less pronounced than and similar to that of *miliacea*; no distinct black patches on costal margin; stigma with a basal hyaline spot and another rounded median spot, a third spot being present only on one wing; the remainder of the wing is slightly infuscated, with large rounded, indistinct hyaline spots disposed in two series in the submarginal and first posterior cell and in three irregular series in the second and third posterior cells, and also in the distal half of discal cell. Inner cross-vein broadly margined with fuscous, but the darkest part of wing is the stigma.

EPICERELLA MACULIPENNIS, n. sp.

Characterized by the black facial stripe and by the wings having distinct black patches along the costal margin.

Type female, in the Health Dept. collection, from Gisborne, Victoria, December 18, 1921 (G. Lyell). Two specimens taken *in copula*, Lakes Entrance, Victoria, October, 1919 (F. E. Wilson, sent by H. G. Hill).

Female.—Length of body and wing, 7·5-8 mm. Head and its appendages as described for the preceding species; frontal stripe narrower and clothed with longer and more numerous hairs, principally on anterior part, even the short orbital plates are black like the ocellar spot; third antennal segment with a well developed upper apical point, face with a black stripe along the central keel and the supraoral plate in part black; peristomalia with a blackish elongate mark below eyes; postverticals rather long and diverging, two orbitals, the upper one shorter, ocellars small but distinct, genal bristles strong. Mesonotum with a distinct pattern, consisting of four blackish vittae, the outer pair broadest and beyond the suture an additional supra-alar vitta; humeri and notopleural region pale yellowish; pleura with large black spots; scutellum, mesophragma, and the hypopleural spots as in preceding species; chaetotaxy similar, but the dorsocentrals extending to the suture; three strong mesopleurals. Halteres whitish. Abdomen subopaque reddish, with black pubescence and bristles; in the male the first segment is as long as the two succeeding segments combined, the fourth is as long as the third; in the female the first segment is as long as the four following segments combined, the ovipositor is longer than the abdomen and broader than it, shining reddish, clothed above with rather numerous short and thick bristly black hairs which are longer below, gently convex above, and blunt at apex. Legs as in preceding species, the femora sometimes slightly infuscated, and more bristly, the fore pair being provided below with a series of short bristles besides the long rigid basal bristle. Wing venation as in preceding species, but a stump present on second vein; the stigma has also a basal and a middle hyaline spot, and sometimes a small round dot is present at apex. Characteristic of the species are the black patches on costal margin forming almost bands, one before stigma and origin of

second vein, one on the inner cross-vein, one over the outer part of all but end of marginal cell, continued below in apex of submarginal and first posterior cell. The hyaline spots are uneven and well defined, but those in middle of submarginal cell and base of first posterior cell are confluent. The darker apices of submarginal and first posterior cells have two series of irregular hyaline spots, in the second posterior, third posterior, and terminal half of discoidal cells, the rows are three but always irregular.

EPICERELLA MINOR, n. sp.

Differs from the preceding species in being smaller, and in the different antennae and wing markings.

Type male, a specimen from Mt. Kosciusko, December 7, 1922 (Goldfinch) in the Health Dept. collection. A poorly preserved female specimen from South Australia is placed doubtfully here.

Male.—Body and wing 6 mm. Head as in the preceding species and with the same chaetotaxy, but the ocellars are not distinct and there is but one orbital. The frontal stripe is narrower, being only a little wider than one parafrontal. Third antennal segment reddish, rounded at apex, with a prominent, more acute, upper apical angle. Black facial stripe and dark peristomial spots as in preceding species. Thorax as in that species, the three dorsocentrals extending to suture. Abdomen similar, with shining blackish stripes on sides of third and fourth segments; the ovipositor of the supposed female is very like that of the preceding species both in form and vestiture. Legs as in that species, extremities of femora and tibiae of hind pair infuscated. Wings with same venation and very similar pattern, no stump on second vein, the hyaline spots are less numerous but disposed in the same way, the blackish spots along the costa are not distinct, being limited to the second vein and not extending below, thus there is no distinct spotting of the costa.

4. ACROPYRGOTA Hendel.

This peculiar Australian genus was compared with *Toxura* by Hendel, but I think it is more closely related to *Adapsilia*. The basal abdominal segment is longer than in *Toxura*, though not so long as in the other genera, but the absence of ocelli and the presence of but two notopleurals (1:1) distinguish it from *Toxura*. From *Adapsilia* and all other genera it is distinguished by the pointed third antennal segment. The second wing-vein never has a stump of a vein as in *Adapsilia*, and the fourth vein is curved down before inner cross-vein.

The species may be distinguished as follows:

1 (2). Head distinctly swollen; abdomen reddish; wings hyaline .... *flavescens* Hendel
2 (1). Head not swollen; abdomen black; wings infuscated, with numerous hyaline dots ..... *cribripennis*, n. sp.

ACROPYRGOTA FLAVESCENS Hendel.

Arch. f. Naturgesch., 1913 (1922 in Bezzi's ms.), p. 112, fig. 12.

Described from a female, without locality, but listed by Hendel as from Australia. Type in British Museum. Not seen.

ACROPYRGOTA CRIBRIPENNIS, n. sp.

A robust fly, distinguished by its pointed third antennal segment, and its wings very like those of *Epicerella miliacea* Hendel, from which it is distinguished by the black abdomen, different antennae, and lack of ocelli.

Type male, Bright, Victoria (H. V. Davey); allotype, Singleton, December 30, 1923 (Nicholson).

Male and female.—Length of body and wings 11-13 mm. Occiput opaque reddish, pale yellowish on the lower swelling, and with four black stripes radiating from the neck to the eyes; the scattered hairs are black. Frons about as wide as one eye, or a little narrower; no vertical keel, but the ocellar triangle is prominent, bearing however no distinct ocelli, the central stripe is opaque reddish and bare, the parafrontals are whitish, with sparse black hairs, and a short black stripe at insertion of orbital bristle; ocellar spot whitish; in profile the frons is projected about as far as width of antenna. Eyes oval; parafacials whitish, as broad as antenna, with some white hairs; cheek about one-third as high as vertical diameter of eye; facial grooves about half as long as face, separated by a narrow yellowish keel; antennae short, dusky yellowish at bases, blackish at apices, second segment as broad as, and a little longer than, third, with short pale hairs, third segment triangular, very sharp at apex; arista short, yellowish at base, bare, a little longer than antenna, thickened at base, slender apically. Bristles black; two verticals, postverticals long and diverging, two orbitals, but the basal (*sic*) one often indistinct. Mesonotum reddish, a little shining, with faint greyish dust, and with four blackish vittae; pleura shining reddish, with blackish or brownish shading; humeral one, notopleurals two (1:1), dorsocentrals one pair; sternopleural one, scutellum blackish-brown, yellowish on sides, and with 6-8 marginal bristles. Halteres pale yellowish. Abdomen entirely black even on venter, shining above, in the male the first segment is as long as fourth and the second and third are of equal length, the female has the first segment as long as second and third combined, the following very narrow; hairs and bristles black. Legs usually reddish, the femora sometimes infuscated; hairs and bristles black; claws very large. Wings with the usual venation, about as in Hendel's figure of the wing of *miliacea*, with stump on second vein; the fourth vein is curved downward into discal cell before inner cross-vein, the cell being narrowed at base. In my specimen of *miliacea* the fourth vein is straight, while Hendel's figure shows the vein a little curved. Wings infuscated and with hyaline spots, differently marked in the two sexes. In the male the spots are very uneven and small, well separated, three rows in the first posterior cell, 4-5 irregular rows in the second and third posterior cells, and three rows in the apical portion of discal cell. In the female the spots are much less numerous, browner, and confluent, only two or three rows in the cells.

5. Adapsilia Waga.

This genus is recorded here for the first time from Australia, and is one of the few genera not peculiar to the continent. The species here described is of ordinary form and is a typical member of the genus, showing a great resemblance to *flavopilosa* Hendel described from Japan, from which it is distinguished by the entirely hyaline wings.

Adapsilia illingworthiana, n. sp.

A reddish fly of large size, with entirely yellowish hairs and bristles and immaculate wings.

Type, a single male specimen from Cairns, N. Queensland, collected at light by Dr. J. F. Illingworth and named in his honour.

Male.—Length of body and wing 12 mm. Occiput opaque reddish, without black markings, and with reddish pubescence, lower swelling much developed,

darker than the surrounding parts; vertical keel high, the ocellar region dark behind, and pale before keel. Frons short, twice as wide as one eye, opaque reddish, with a dark spot at base of each orbital bristle; it is flat above, and in profile projects as far as horizontal diameter of the very narrow eyes, the latter have their hind corner at level of ends of grooves; the very broad parafrontals are glistening, with sparse scattered yellowish hairs above, the hairs on anterior part of frontal stripe longer. Antennae proportionately long, entirely reddish, second segment rather slender, twice as long as first, with short reddish hairs, third segment distinctly longer than second, not much attenuated on its apical half, truncate at tip; arista basal, longer than whole antenna, thickened basally. Antennal grooves shining reddish, elongate, with a sharp keel between them, terminal plates below the grooves opaque yellowish, darkened above, a little prominent in profile; cheeks broad, two-fifths of antennal length, shining on upper half, opaque on lower half, with a blackish elongate spot below lower corner of eye, bare at border. Palpi yellowish, with yellowish bristles; proboscis thick and short, with pale hairs. Bristles reddish, usually only one pair of postverticals and one pair of orbitals, and a smaller outer pair present. Mesonotum entirely reddish, slightly shining, with short reddish pubescence, humeri paler than surrounding parts; pleura and mesophragma reddish-yellow, shining, without paler or darker parts; one humeral, three notopleurals, one pair of dorsocentrals, one sternopleural, and 1-2 mesopleurals. Scutellum coloured as mesonotum, with four yellowish bristles. Halteres pale yellowish. Abdomen entirely reddish, slightly shining, immaculate, with reddish hairs and bristles; first segment constricted on basal half, scarcely as long as rest of abdomen. Legs entirely reddish, with reddish bristles and hairs, last segment of all tarsi dilated. Wings greyish hyaline, unspotted, veins entirely reddish, normal; stump of second vein strong, but not long; inner cross-vein at one-third from apex of discal cell; outer cross-vein at about its own length from inner one; lower angle of anal cell rather long and acute; fourth vein straight before inner cross-vein; third vein bare at base.

6. Campylocera Macquart.

This genus is well represented in the Ethiopian region. The species of the Oriental region are not entirely typical, having the fourth vein distinct to apex, but the costal vein is prolonged only a little beyond the apex of third vein. There is no stump of a vein on second vein.

The single species recorded from the Australian region is from New Guinea, and has the apex of fourth vein rather evident. There is a second species occurring in this region, the two being distinguished as below.

1 (2). Outer cross-vein of wing straight; apices of veins 2 and 3 infuscated; peristomalia broad, one-third as high as vertical diameter of eye ..... *brevicornis* Hendel

2 (1). Outer cross-vein of wing curved on its lower part; apices of veins not infuscated; peristomalia much narrower ..... *curvinervis*, n. sp.

Campylocera brevicornis Hendel.

Wien. Ent. Zeit., 1908, p. 132.

A yellowish fly, with blackish abdomen and tibiae, and with the wings marked as stated above. New Guinea.

Campylocera curvinervis, n. sp.

Closely allied to the preceding species, but easily distinguished by the characters cited in the key above. Distinguished from *fuscipes* van der Wulp by the yellow femora and unspotted wings.

Numerous specimens of both sexes in Health Dept. collection from Manly, 10-15 November, 1922, and Sydney, N.S.W., December 3, 1922.

Male and female.—Length of body 7-9 mm., of wing 6-8 mm. Occiput entirely opaque reddish, unspotted, clothed with rather long and dense black hairs. Frons parallel-sided, narrower than one eye (in male as broad as), 1·5 times longer than wide, opaque reddish, clothed with black hairs, and with a dark ocellar spot; parafrontal very narrow, shining yellowish, not prominent in profile. Face very narrow in female, the parafacial being linear, broader in male, equal to eye; facial grooves long, shining reddish, extending about to mouth border, divided by a sharp central vertical keel. Eyes oval, vertical diameter twice that of longitudinal, anterior central facets much enlarged, notably in the female. Peristomalia and grooves reddish, in male equal to width of third antennal segment, in female much narrower, in both with blackish subocular spot. Antennae entirely reddish, long and porrect, second segment attenuated at base and little shorter than third, with black hairs, the third segment oval, little attenuated apically; arista a little longer than antenna, yellowish; palpi yellowish, with short black bristly hairs; proboscis dusky yellowish. Head bristles black, two verticals, one postvertical, one orbital, and four or five short ocellars, the anterior pair longest. Mesonotum shining reddish-yellow, with distinct dusting and dense black pubescence, pleura paler than mesonotum, with longer rigid hairs; humeri pale; scutellum convex, paler than mesonotum, with black hairs and four marginal bristles; mesophragma shining reddish-yellow; all thoracic bristles black; one humeral, two notopleurals, one or two dorsocentrals, one or two mesopleurals, and one sternopleural, all parts with some rigid black hairs. Halteres pale yellowish. Abdomen black above and below, shining above, the first segment is, however, almost entirely reddish-yellow; hairs and bristles black; first segment in female longer than rest of abdomen, about as long as it is in male, in which the apical segment is longer than the preceding segments, about as long as second and third segments combined; genitalia of male reddish; ovipositor of female shining reddish, longer than the entire abdomen, with dense and long, but not strong, black hairs; it is conical, swollen on basal half, suddenly attenuated on terminal half. Legs rather short and stout, with thickened femora, coxae and femora entirely reddish, only the four posterior femora sometimes darkened at apices, hairs and bristles black, all tibiae shining black, with more or less broad reddish bases, all tarsi entirely pale yellowish, or even whitish, all short. Wings broad, greyish hyaline, yellowish at bases and along costa, with no trace of fuscous markings, the veins all yellowish, second vein perfectly straight, without a stump, third bare at base, almost straight, ending at wing tip, the costa produced only a little beyond it, fourth curved downward before inner cross-vein, its apical section complete to tip, or only extreme apex evanescent, rather straight, directed backward, the first posterior cell being thus gradually widened outwardly; inner cross-vein oblique, beyond middle of discal cell, about at apical third; outer cross-vein straight on upper half, strongly bent inward on lower half, the discal cell extending at lower apex almost to margin of wing, the second posterior cell being almost triangular in shape; lower apical angle of apical cell narrow and acute, much produced, sixth vein complete, distinct only at base.

7. Prodalmannia, n. gen.

This genus contains a very striking, rather small species, which, on a superficial examination, might be mistaken for an anthomyiid. It has a great resemb-

lance to some Conopidae, and has a slightly elongated and geniculated proboscis, a character unique in this family; the narrow frons is also an aberrant character.

The generic name alludes to the resemblance to the conopid genus *Dalmannia*, which has a short anal cell, a similar strong ovipositor, and a spirally curved penis in the male. In the genus *Stylogaster* the face is carinate, without grooves, the ovipositor is long, but weak and retractile, etc. In the Myopinae the anal cell is elongate, the penis is not spiral, etc. All these genera have ocelli, and all have the first posterior cell of wing narrowed apically, and even closed.

A rather small species, resembling some species of Anthomyiidae, but with head like that of Myopinae, and strong ovipositor as in Pyrgotidae.

Occiput flat, with slightly developed lower swellings. Frons elongate, flat, between the eyes it is much narrower in the male than in the female, while the anterior half is similarly shaped in both sexes; no vertical transverse keel and no ocelli present; in profile the frons is inclined forward and projects about as far as horizontal diameter of eye. Eyes bare, with small facets, oval in shape, quite small, being about equal in height to that of cheeks. Antennae very small and short, exserted, third segment shorter than second, rounded; arista basal, short, bare; parafacial broad and short; cheek very broad, subquadrate, bare; face short, with the grooves very short, rounded, and coalescent. Lower plate longer than face, flat, not prominent in profile. Mouth opening broad and short; palpi short and cylindrical; proboscis elongate, a little longer than head, with recurved terminal portion, this apparently geniculated, but shorter than the basal one. Cephalic bristles long and slender, two verticals, the inner decussate, one pair of divergent postverticals, and a pair of long reclinate orbitals. Thorax robust, subcylindrical, convex above, with the suture interrupted in middle, propleural tuft developed, one humeral, two notopleurals, and one pair of dorsocentrals; scutellum with three pairs of bristles, the apical ones decussate. Squamae rudimentary. Abdomen parallel-sided, rather flat, basal segment about equally long in both sexes, not constricted at base, male genitalia not visible from above, with spiral penis, female ovipositor strong, only a little shorter than abdomen, and broader than it, with some strong apical spines. Legs rather short and stout, with long hairs and bristles. Wings proportionately narrow, costa extending to apex of fourth vein, auxiliary vein thin, rather close to first vein, complete to apex, joining costa at an acute angle. First vein dilated, ending beyond middle of wing and a little beyond inner cross-vein, approaching gradually to costa, the enclosed cell at apex very narrow, second vein straight, a little backwardly curved on apical part, ending at tip of wing, and ciliated to the inner cross-vein. Fourth vein perfectly straight on all its length before inner cross-vein and on apical section, complete to apex, parallel with third, the first posterior cell not widened at apex; inner cross-vein beyond middle of discal cell, outer one straight, near hind margin; discal cell of normal shape; anal cell long, not much produced apically, its lower angle acute and prolonged; sixth vein extending to margin of wings, alulae large.

Type, the following species.

PRODALMANNIA VARIABILIS, n. sp.

A testaceous, black-spotted species, not unlike some species of the genus *Pegomyia* Robineau-Desvoidy.

Type, Health Dept., numerous specimens of both sexes from Manly, Sydney, N.S.W., November and December, 1923.

Occiput entirely black, a little shining, and dark grey dusted in male, in female the lower swollen parts and the vertical region are reddish; hairs black. Frons opaque reddish, with a broad black band beyond middle, the narrowest part in male is about one-fifth, in female about one-half as wide as one eye, it is without a vertical crest, the hairs and bristles are black, and the orbital pair is rather far from vertex. Antennae entirely deep black, even the arista, which is thickened basally, is so coloured, second antennal segment a little grey dusted, with some black hairs. Parafacials reddish, a little shining; cheek opaque reddish, without a dark mark, with some sericeous reflections, and wider than vertical diameter of eye. Face entirely reddish, central plate below grooves black above, and a black line on each side which extends along lower margins of cheeks. Palpi black, with black hairs; proboscis blackish, with black hairs. Thorax testaceous, shining, with paler coloured humeri and pleura, a black central vitta ending beyond suture, and one on each side of it which is somewhat shorter, usually coalescent; in the female these markings are sometimes much paler, even lacking; pleura with two black marks, one on the sternopleura and the other just above hind coxa; metanotum shining black. In the female there is a narrow black stripe at the base of the halteres. Scutellum testaceous, unspotted. Hairs and bristles all black, unusually long. Halteres pale yellowish. Abdomen shining testaceous, unspotted; in the darker specimens it is sometimes dark brown or blackened on parts. Male genitalia shining black, penis yellow; ovipositor of female shining black, with long sparse fine black hairs, basal spine black, terminal spines reddish. Legs variable in colour, all coxae reddish, femora reddish, more or less blackened apically, or even black with only the bases reddish, tibiae black, more or less reddish at bases, all tarsi deep black, short and thick, claws long, black; pulvilli whitish. Wings greyish hyaline, quite evenly yellowish at bases and on costa, veins yellowish, darkened on distal half of wing.

APPENDIX.

By J. R. Malloch.

(Text-figs. 1-14.)

About three years ago I was informed by the late Dr. M. Bezzi that he had in preparation a revision of the Australian Pyrgotidae, and some months before his death he assured me that the manuscript was practically complete. Subsequently the late Dr. E. W. Ferguson informed me that he had been unable to obtain any information from Dr. Bezzi as to when the manuscript would be submitted for publication, and on the death of Dr. Ferguson I undertook to obtain it if that were possible. Accordingly I wrote to Madame Bezzi regarding the manuscript and also the material upon which it was based and in due course received the former, but failed to get the specimens. I have just recently obtained the latter from Prof. B. Parisi of the Natural History Museum of Milan, where the Bezzi collection is now deposited, and am able to make a few figures and additions to the text which will better enable students to identify the species involved. My best thanks are due to Prof. Parisi for his assistance in this matter.

The manuscript was in part in the form usually submitted by Dr. Bezzi for printing, but much of it was in first draft form. By dint of careful work I have compiled a typewritten copy and am confident that with the exception of a few minor grammatical changes I have succeeded in accurately transcribing the text of the paper. Without figures it would be difficult for the tyro in this

family to make use of the paper with a great degree of success so I have furnished a number showing details of the species involved. The family is a very difficult one to work with and the discovery of more species will entail comparison with types to distinguish them satisfactorily from the species included in the present paper.

The genus *Pyrgota* in North America possesses two characters, the discovery of which caused me some years ago to publish the opinion that the genus is closely related to Conopidae, and not closely related to Ortalidae in which latter family it has generally been placed. These two outstanding characters are the absence of ocelli and of the prong-like process on outer side of mid coxa which is so conspicuous in most cyclorrhaphous Diptera, but the prong or both prong and ocelli are absent in Conopidae. These two characters hold good for all the species of Pyrgotidae occurring in the Nearctic region, and for the greater part for those genera in Central and South America which have been placed in the family by other authors.

In Australia, however, we find that if all the species placed in the family belong therein either or both of the characters fail, a number of the genera possessing both ocelli and mid coxal prong. In fact some of the genera in the foregoing paper are more evidently related to Ortalidae than they are to Conopidae, and the isolation of the family on structural grounds becomes difficult indeed, almost the only means of separation then consisting of the peculiar cylindrical or subcylindrical, and more or less conical, sheath of the female ovipositor. This portion of the abdomen is not the true ovipositor as one would infer from descriptions that have appeared, but is a horny container for the true ovipositor, which is lance-like and not very different from that of many Ortalidae and Lonchaeidae.

In his introductory remarks in this paper Dr. Bezzi enumerates the principal characters of the family. Taking these characters in order, and using as a basis the species of the two hemispheres, we find that the ocelli are invariably lacking in those species which have no mid coxal prong, though some species which have a rudimentary prong lack the ocelli also, and rarely there are only two rudimentary ocelli present; the lunule is not always concealed; the prelabrum is variable in size; there is never a well developed propleural bristle present, but this is frequently lacking in Ortalidae; the tibiae have sometimes a weak dorsal bristle close to apex; the first vein is invariably setulose above, but it is so also in many Ortalidae, etc., and the third vein is frequently setulose at base above; lower apical angle of anal cell with or without an acute production; penis spiral, but frequently so in Ortalidae and some other families.

It must be apparent from a perusal of the foregoing list of characters that the segregation of genera into families is attended with considerable uncertainty if those are the only characters available. But if one takes the two characters which are invariably indices to the Pyrgotidae of the New World, and in addition to these the lack of any longitudinal dorsal cleft in the second antennal segment, I believe the problem will be solved for the Australian region.

We will then have in Pyrgotidae only species which have the second antennal segment entire (Text-fig. 1), the ocelli lacking or rudimentary, and the mid coxae without a well developed prong. In addition the empodium is without a fringe of fine hairs. The species resembling Pyrgotidae most closely belong either to Platystomidae or Ortalidae. The former is generally considered a subfamily of Ortalidae, and contains a few genera that may be confused with Pyrgotidae,

but they have the second antennal segment deeply cleft above, and the lower calypter very large, in fact as large as in many Tachinidae, besides possessing a distinct mid coxal prong. The lower calypter is shorter than upper in Pyrgotidae, usually very rudimentary. The other genera, including *Toxura* Macquart, I would assign to the Ortalidae on account of the presence of ocelli, a well developed mid coxal prong, or a cleft second antennal segment. In most Ortalidae and related families likely to be confused with Pyrgotidae the empodium is fringed to, or almost to, apex.

I hope shortly to be able to publish a paper on the Pyrgotidae of the New World in which the status of the family will be more thoroughly discussed, but in the meantime present the data given above that they may be available to Australian students.

It is not proper that I should alter the main part of this paper in any manner, but below I present a key to the genera available to me, using for their separation a different set of characters from those used by Dr. Bezzi, and dividing his concept of *Toxura* into two segregates. This is done at the present time so that the matter will the more readily be available to students than if I embodied my system in a separate contribution. Generic concepts are variable with authors and it is very probable that in one or two cases the Australian genera as now accepted will be further divided, and particularly is this likely with *Epicerella* Macquart which appears to me to be composite, as herein included. However, the matter is one for future consideration by some worker to whom more material is available.

Key to the Genera.

1. Subcostal vein rectangularly bent forward at apex which is well removed from apex of first vein, the latter not swollen at apex, and distinct to tip (Text-fig. 2); ocelli normally evident; second antennal segment almost invariably distinctly cleft above at apex; mid coxal prong well developed (*Toxurinii*) 2

   Subcostal vein not rectangularly bent forward at apex; if the extreme apex is poorly developed, it lies close to apex of first vein and the latter is almost invariably swollen apically and more or less fused with costal vein (Text-fig. 13); if the first vein is distinct to apex, the second antennal segment is cleft and the mid coxal prong is present 6

2. Notopleural bristles 1 + 2 or 3; base of third wing vein setulose above; first vein bent forward at extreme apex; each frontal orbit with two bristles above; scutellum haired on disc ..... *Neotoxura*, n. gen.

   Notopleural bristles 1 + 1; base of third wing vein usually bare above 3

3. Scutellum haired on disc; cheek about two-thirds as high as eye ..... *Acropyrgota* Hendel*

   Scutellum bare on disc, with only marginal bristles 4

4. First wing vein ending at or before level of inner cross-vein; cheek almost as high as eye; presutural bristle absent ..... *Toxura* Macquart

   First wing vein almost invariably ending distinctly beyond level of inner cross-vein; cheek rarely more than one-half as high as eye; presutural bristle present .. 5

5. Fourth wing vein with a pronounced curve into discal cell in front of inner cross-vein, the discal cell very much narrower proximad of inner cross-vein than beyond it ..... *Epicerella* Macquart, part

   Fourth wing vein not noticeably curved into discal cell proximad of inner cross-vein, that cell gradually and rather regularly widened from base to apex ..... *Epicerella* Macquart, part

6. Second antennal segment with a distinct longitudinal cleft at apex on upper side .. 7

   Second antennal segment without a distinguishable longitudinal cleft at apex on upper side 9

* I have not seen the genotype of this and it may not belong to Toxurinii.

7. Ocelli well developed; head in profile quadrate, frons in both sexes about half the head width, face with a flat central carina which is narrower above, becomes wider below, and has the lateral edges sharp, antennal grooves deep, centre of face projecting beyond antennae in profile (Text-fig. 8); third wing vein setulose at base above, venation as in Text-figure 9 ..... *Maenomenus* Bezzi
Ocelli lacking; head higher than long; facial carina not as above, without sharp lateral edges, antennae quite evident in profile (Text-fig. 12) 8
8. Frons of male at vertex about one-seventh of the head width, that of female not one-third of head width at same point; profile of head as in Text-figure 12; vein closing anal cell slightly biangulate ..... *Prodalmannia* Bezzi
Frons of male at vertex more than half of the head width; profile of head as in Text-figure 10; vein closing anal cell practically straight ..... *Frontalia*, n. gen.
9. Vertex distinctly elevated, almost carinate ..... *Adapsilia* Waga
Vertex not at all elevated 10
10. Fourth wing vein evanescent at apex, the costa discontinued a little beyond apex of third vein; prosternal plate elevated and haired on sides; third wing vein bare at base ..... *Campylocera* Macquart
Fourth wing vein distinct to apex, the costal vein narrowed beyond apex of third vein but quite evident to apex of fourth; prosternal plate flat and bare; third wing vein setulose at base above ..... *Nicholsonia*, n. gen.

Tribe **Toxurinii**.

I propose to include in this tribe the genera *Toxura* Macquart, *Epicerella* Macquart, and *Neotoxura* Malloch, with possibly also *Acropyrgota* Hendel, the last being unknown to me except from the description. The group does not, in my opinion, belong to the family Pyrgotidae, but to Ortalidae. I base my conclusion upon the fact that the species have the second antennal segment cleft, possess a mid coxal prong, and usually also more or less well developed ocelli. A striking character which distinguishes them from most Ortalidae is the subapical rectangular bend of the subcostal vein of the wing. In this character the species are very similar to typical Trypetidae, but all the members of the latter family have incurved bristles on the anterior half of each frontal orbit, which are never present in either Ortalidae or Pyrgotidae.

Neotoxura, n. gen.

This genus contains at least four of the species placed by Bezzi in *Toxura*. It differs from that genus in having the posterior notopleural bristle duplicated, the base of third wing vein setulose above, face almost vertical and without a pronounced central hump, the lower angles of facial ridges not noticeably closer than central portions and below lower margins of eyes, each orbit with two bristles on upper portion, and the scutellum haired on disc.

Bezzi did not have the genotype of *Toxura* in his material, hence his alignment of the species in the preceding paper.

Genotype, *Toxura discoidalis* Bezzi. (Text-fig. 2.)

The other three species which I place in this genus on the basis of material in hand are *Toxura robusta* Bezzi, *Toxura variegata* Hendel, and *Toxura longipalpis* Hendel. I doubt whether *Toxura microps* Hendel can be referred here, and am almost certain that *T. angustifrons* Hendel can not be.

The key given in the main part of this paper will suffice for the identification of the species of the genus now generically distinguished from *Toxura*.

Neotoxura longipalpis (Hendel).

Readily distinguished from its congeners by the deep black antennae and palpi.

Locality, Wahroonga, Sydney, N.S.W., 24.10.1926. Submitted by Dr. E. W. Ferguson, but the specimen bears no collector's name.

Toxura Macquart.

I have before me a specimen which I identify as *maculipennis* Macquart, the genotype, though the markings of the wings are larger than in Macquart's figure and there is a small hyaline spot in outer apical angle of the preapical mark not shown by him (Text-fig. 3).

The specimen differs from the species placed by me in the preceding genus in the following characters: Posterior notopleural bristle not duplicated, base of third wing vein bare above and below, face with a quite pronounced hump which is highest about middle of head in profile, the facial ridges convergent below, the angle situated at or above lower level of eyes, each orbit with one bristle above, postverticals lacking; first vein gradually approaching costa apically, its tip not beyond inner cross-vein; palpi strap-like; scutellum bare on disc.

Toxura maculipennis Macquart.

This species would be difficult to identify by the use of the key given in the main part of this paper as the wings might as reasonably be considered banded as those of *variegata* and *robusta*, though the two prominent black marks on the costa do not pass much beyond the fourth vein on the field of the wing.

Locality, National Park, Sydney, N.S.W., 21.3.1925 (Health Dept.).

Epicerella Macquart.

This genus as accepted by Dr. Bezzi is more diversified than any other in the Australian fauna, and I am undecided upon the propriety of distinguishing the various segregates as genera or even subgenera.

Of the three previously described species only one is amongst the material now available, and that one is not the genotype. I have removed *Acropyrgota cribripennis* Bezzi to this genus as it agrees better with *Epicerella* than with *Acropyrgota*, though the genotype of the latter is also unavailable to me. The key presented in the main part of this paper will suffice for the separation of the species included therein, and below I present a supplementary key which includes only the species actually available for examination, two of which were not in Dr. Bezzi's material.

Key to the Species.

1. Mesonotum with at least two pairs of well developed postsutural dorsocentral bristles; second wing vein usually without an appendage 2
   Mesonotum with only one pair of well developed dorsocentral bristles; second wing vein always with an appendage on underside of apical section 7
2. Lower calypter with some long hairs on margin which are mostly longer than calypter; pterostigma (i.e., section of cell between apices of auxiliary and first veins of wing) fuscous, slightly paler at base 3
   Lower calypter densely downy or pubescent on hind margin, without outstanding hairs; pterostigma fuscous, with a well defined hyaline spot at base and another at, or near, apex 4
3. Each orbit with one bristle; wing markings more extensive and darker, the dark mark over inner cross-vein extending posteriorly to furcation of second and third veins ..... *plagiata* Bezzi
   Each orbit with two bristles; wing markings less extensive and paler, the apical portion of first posterior cell with a dark mark at furcation of second and third veins and another over inner cross-vein ..... *setosa* Bezzi

4. No hyaline spots in the apical fuscous portion of wings between second vein and the costa, and only a hyaline streak in it on apical section of submarginal cell (Text-fig. 5); face entirely yellow; ocellar triangle deep black, shining, the ocelli entirely lacking in type (male) ..... *triangularis*, n. sp.
   One or more hyaline spots in the dark apical portion of wing in the submarginal, and almost invariably also in the marginal cell (Text-fig. 7); face partly dark brown or black except in *strumosa*; ocelli always present, sometimes small 5
5. Face without a dark stripe; sheath of ovipositor of female with fine short hairs on entire surface, a few longer and stronger hairs at apex below .. *strumosa* Bezzi
   Face with a conspicuous black central stripe, very wide below; sheath of ovipositor of female with quite strong bristles on sides of dorsum and at least the apical half 6
6. Fore femur of male with some well developed bristles on basal half of posterior, and apical half of posterodorsal, surface; second wing vein with an appendage ..... *maculipennis* Bezzi
   Fore femur of male without distinguishable posterior or posteroventral bristles; second wing vein without an appendage ..... *minor* Bezzi
7. Third wing vein setulose at base above; hind coxae of male black haired below, the hairs very short in front, becoming denser and longer to posterior margin, the trochanters similarly but less densely haired, both coxae and trochanters in female with a ventral patch of dense black spinules ..... *miliacea* Hendel
   Third wing vein bare at base above and below; hind coxae in neither sex densely haired below 8
8. Large species, more than 10 mm. in length; scutellum with at least six marginal bristles; no outstanding bristles on hind femur of male, a few of moderate length on apical half of dorsal surface in female; ocelli present .... *cribripennis* Bezzi
   Smaller species, about 7 mm. in length; scutellum with four marginal bristles; two or three outstanding bristles of about the same length as diameter of femur on apical half of anteroventral and dorsal surfaces of hind femur; ocelli lacking ..... *multipunctata*, n. sp.

Epicerella plagiata Bezzi.

This species is very similar to *setosa* and the two may eventually be found to represent the sexes of one species. The character of the dorsocentral bristles cited by its describer in his key for separating it from *setosa* is not used by me because I think that the type specimen of the latter is abnormal in this respect, the series of bristles that is intact in the type suggesting this conclusion by their irregular arrangement. More material is essential to decide the question, but meanwhile the evidence would appear to justify them being considered as distinct. In both species there are a very few hairs on the mesosternum in front of the series of bristles on the hind margin, and this character distinguishes them from nearly all the others in the section of the key set apart by the characters cited in section 1 of caption 1 of the key presented above.

The fore femur of the type of *plagiata* has the basal ventral bristle much longer than does that of *setosa*, but this is the case in the sexes of *maculipennis* also.

Epicerella setosa Bezzi.

A noteworthy feature of the female type is the exceptionally strong bristling of the sheath of the ovipositor. The bristles on the sides are quite strong and slope upward, the central portion of dorsum on basal half is less strongly and densely bristled, and there is a bare median stripe on apical half of disc, the central portion of basal half of venter is furnished with rather closely placed strong sharp-pointed bristles, and laterad and apicad of these the surface has much sparser, finer, and longer, bristles. The basal ventral bristle on fore femur is one and a half times as long as diameter of femur.

I can trace no similarity between the wing markings of *Neotoxura discoidalis* and this species, contrary to the statement of the author of both. The sheath of the ovipositor and many other characters are radically different in the two species.

EPICERELLA MILIACEA Hendel.

I accept Bezzi's identification of this species, though the examples in the collection do not agree in all particulars with Hendel's description. It appears pertinent to state that the term "peristomalia barbate" may be misleading. There is a series of fine closely placed hairs along the margin of the cheek and extending upward to level of facial protuberance, but except for the fact that these hairs are longer than usual there is nothing noteworthy in their presence, as similar hairs are present in all the species of the genus. Also the pterostigma is not invariably tripunctate, the male in the collection having two spots on one wing and three on the other. In fact the variation in maculation in the species with multipunctate wings is so great that such markings can be used only in a general way for purposes of specific identification.

EPICERELLA STRUMOSA Bezzi.

The type specimen of this species appears to have been at one time in liquid and is slightly bleached so that the immaculate face may not be the normal condition.

EPICERELLA CRIBRIPENNIS Bezzi.

I have a male which appears to belong here, but a series is necessary to make clear the limits of variation in the species.

Locality, Townsville, Queensland, 26.11.1926, at light (F. H. Taylor).

EPICERELLA TRIANGULARIS, n. sp.

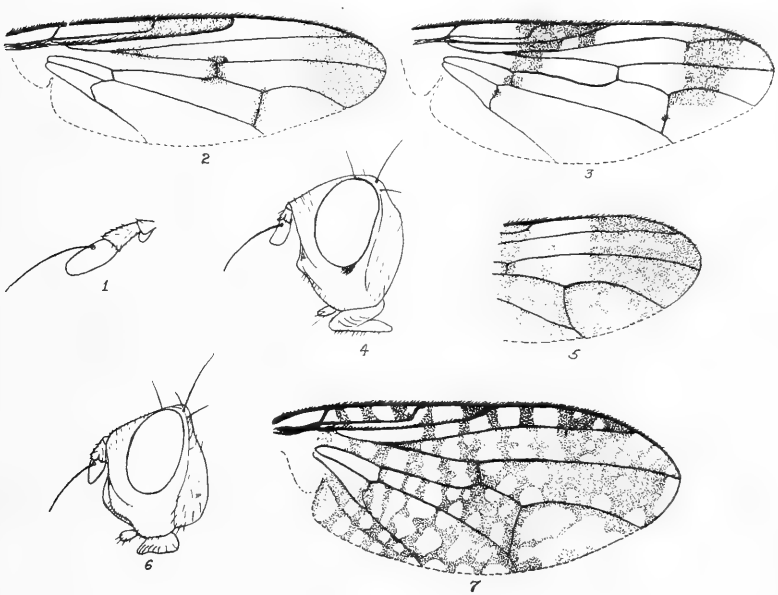
Male.—Testaceous yellow, slightly shining. Ocellar triangle shining black, quite conspicuous, anterior portion of frons orange, a dark mark below each eye on centre of cheek, face entirely pale; antennae and palpi yellow. Thorax with four brown dorsal vittae, the submedian pair abbreviated behind, the sublateral pair abbreviated in front, a brown supra-alar mark, a pale brown stripe on each side of disc of scutellum, and brown marks on anterior and lower margins of mesopleura, centre of pteropleura, the sternopleura above halteres, and on all of postnotum. Abdomen slightly tinged with brown on parts. Legs yellow. Wings marked with brown, most conspicuously so on costa from before apex of auxiliary to apex of first vein (the pterostigma with two pale spots), over both cross-veins, and on apical section (Text-fig. 5).

Head in profile as Text-fig. 4; frons parallel-sided, more than one and a half times as long as wide, outer vertical bristles about half as long as the inner pair and quite well developed, equal in length to the pair of orbitals, the latter with a very fine hair behind each, postverticals short and hair-like, ocellar triangle well defined, extending almost to level of the orbitals, no ocelli evident; third antennal segment angulate on upper extremity; palpi strap-like. Thorax with two pairs of strong postsutural dorsocentrals, the other bristles also well developed, scutellars four in number; propleura with a vertical series of three or four bristles and some fine short hairs centrally, and a few microscopic hairs on extreme lower margin. Abdominal tergites 2 and 4 subequal in length, the

lateral bristles not very long. Hind femur with one or two outstanding preapical dorsal bristles, no other femoral bristles evident. Inner cross-vein at about two-fifths from apex of discal cell; no appendage on second vein, though there is a slight flexure where such would normally occur indicating the possibility that it may possibly be present in the species.

Length, 6 mm.

Type, Cairns, N. Queensland (J. F. Illingworth).



Text-figure 1.—Antenna of *Campylocera hyalipennis*.
Text-figure 2.—Wing of *Neotoxura discoidalis*.
Text-figure 3.—Wing of *Toxura maculipennis*.
Text-figure 4.—Head of *Epicerella triangularis* from the side.
Text-figure 5.—Apex of wing of same.
Text-figure 6.—Head of *Epicerella multipunctata* from the side.
Text-figure 7.—Wing of same.

EPICERELLA MULTIPUNCTATA, n. sp.

Male.—Similar in general appearance to the preceding species, but much darker in colour. Head brownish testaceous, frons with two brownish vittae, broader in front, ocellar triangle not well defined, greyish dusted and not darker than the ground colour of frons; antennae fuscous; face with the linear portion of the carina, and a mark on each side of the lower wide portion of same, fuscous; a dark spot opposite base of third antennal segment on parafacial; palpi brown. Thorax darker than head, the dorsum grey dusted and with four broad fuscous vittae, scutellum brown on disc; pleura largely infuscated. Abdomen variable in colour, sometimes (type♂) almost entirely fuscous. Legs brownish testaceous, apices of femora more or less darkened, especially on the under side. Wings with many clear dots on a brown ground.

Head in profile as Text-fig. 6; verticals as in *triangularis*, postverticals much stronger than in that species, no fine hair behind the single strong orbital; third antennal segment tapered to apex. Thorax as in *triangularis*, but with only one pair of strong postsutural dorsocentral bristles; the centre of propleura with more numerous bristles, and the mesopleura with two closely placed strong bristles on hind margin, instead of but one. Legs rather stout, fore femur with a few short posteroventral bristles, hind femur with two or three preapical dorsal bristles and a few shorter preapical anteroventral bristles. Venation of apical section of wing as in Text-fig. 7, the appendage to second vein quite prominent.

Length, 6-7 mm.

Type, Cairns, N. Queensland; paratype, Gordonvale, N. Queensland (J. F. Illingworth).

The paratype is much paler in colour than the type, and the frontal triangle is considerably shorter, but I can detect no other distinctions between the specimens and consider they belong to the same species.

The next two genera are not referable to Toxurinii, nor are they properly placed in the family Pyrgotidae in my opinion, though there are characters which appear to indicate the possibility of their being intermediate forms. Unfortunately hard and fast rules for the differentiation of the families seem impossible of attainment and further material may yet prove or disprove the correctness of my present alignments.

Maenomenus Bezzi.

This genus is a difficult one to assign satisfactorily to a family, but despite the similarity in the sheath of the ovipositor to those of certain Pyrgotidae I am convinced that it is not referable to that family. The carinate face, cleft third antennal segment, and presence of a mid coxal prong, combine to place it in the Ortalidae, with the bulk of evidence indicating its position in Platystominae. There is, however, plenty of latitude for a difference of opinion as to the limits of the Ortalidae and especially as to the contained subfamilies, and while I do not accept the genus as belonging to the Pyrgotidae, I am not committed to the opinion that it is referable to Platystominae. In any of the accepted families the genus is abnormal.

I figure the head (Text-fig. 8), and the wing (Text-fig. 9) to facilitate identification.

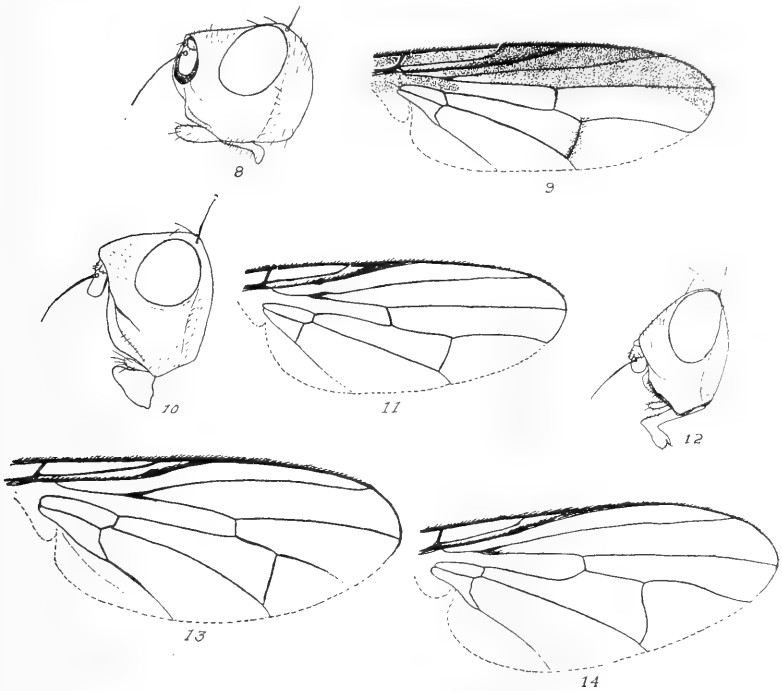
Frontalia, n. gen.

This genus also is a rather aberrant one, possessing practically all the characters of Pyrgotidae except the simple second antennal segment and the angulation of the vein closing the anal cell of the wing. The mid coxal prong is lacking in this genus and present in *Maenomenus*.

Head in profile as in Text-fig. 10; frons about three times as wide as one eye and fully as wide as long, inner verticals present, erect, longer than the other bristles, outer verticals lacking; postverticals rather widely separated, directed forward and outward, one bristle on each orbit which is situated at about its own length from eye and directed outward (in type); face with a sharp central carina, space between facial ridges at angles not more than half as great as that from either to eye; second antennal segment cleft, on inner side almost as long as third segment, but distinctly shorter than it on outer side; palpi

slender. Thorax as in *Pyrgota*; notopleurals 1 + 1, two pairs of postsutural dorsocentrals present, the anterior pair short, the posterior pair proximad of the pair of moderately long prescutellar acrostichals; scutellum bare on disc. Wing-venation as Text-fig. 11.

Genotype, the following species.



Text-figure 8.—Head of *Maenomenus ensifer* from the side.
Text-figure 9.—Wing of same.
Text-figure 10.—Head of *Frontalia genalis* from the side.
Text-figure 11.—Wing of same.
Text-figure 12.—Head of *Prodalmannia variabilis* from the side.
Text-figure 13.—Wing of *Campylocera hyalipennis*.
Text-figure 14.—Wing of *Nicholsonia curvinervis*.

Frontalia genalis, n. sp.

Male.—Head rufous yellow, vertex and occiput more brownish, third antennal segment, aristae, and apices of palpi, fuscous. Thorax brownish-red, dorsum with slight grey dust, and traces of four pale vittae separated by darker lines. Abdomen brownish-black, slightly shining, and with faint pale dust on dorsum. Legs coloured as thorax, apices of femora darker. Wings hyaline, veins yellow. Halteres dull yellowish-brown.

Frons with microscopic hairs, those on sides of occiput longer, but inconspicuous. Thoracic dorsum with rather dense, short, stiff, decumbent, black hairs; scutellum subtriangular, convex, with four equal bristles. Abdomen short and stout, basal tergite not much longer than second. Legs stout, no bristles present.

Third wing vein bare at base, costa with a slight indication of a break at apex of subcosta.

Length, 4·5 mm.

Type, Glen Forest, Darling Range, W.A., 11.9.1926. No collector's name on the label.

PRODALMANNIA Bezzi.

This genus would, in my opinion, fall close to the foregoing one, but it is very different in the structure of the head. Dr. Bezzi refers to its resemblance to certain Conopidae and the generic name is proposed with this resemblance in mind, *Dalmannia* being a genus of that family.

I figure the head of *Prodalmannia variabilis* Bezzi (Text-fig. 12), and add to the records the occurrence of three males at Sydney, 30.11.1924, submitted to me by Dr. E. W. Ferguson.

Family Pyrgotidae.

Of the genera which are in the main part of this paper, only *Campylocera* Macquart and *Adapsilia* Waga are referable to Pyrgotidae in my opinion. The genus *Nicholsonia* proposed herein for the reception of *Campylocera curvinervis* Bezzi belongs also to this family. All three are represented by single species in the material now before me, but possibly more species occur in Australia.

I figure certain characters of two of the included species.

CAMPYLOCERA Macquart.

The single Australian species which I place in this genus is very similar to the African species *oculata* Hendel and *latigenis* Hendel, but differs from both in the structure of the head and the sheath of the ovipositor.

The genus is well represented in Africa and species have been described from the Orient, the most recent one being *hirsuta* Aldrich, an Indian species reared from beetles of the genus *Adoretus* (Rutelinae).

CAMPYLOCERA HYALIPENNIS, n. sp.

Female.—Shining testaceous yellow, the abdomen more orange-yellow, and the mesonotum with three reddish vittae; all tibiae browned. Wings greyish hyaline, veins brownish-yellow, almost imperceptibly darker at base of third vein and on inner cross-vein.

Frons about one-third of the head width; face below antennae about half as wide as eye at same point; parafacial at base of antenna as wide as third antennal segment, gradually becoming narrower below, quite narrow at lower level of eye; cheeks not as high as width of third antennal segment, with a dark mark below eye; second and third antennal segments about equal in length on upper margins, third almost twice as long as second on lower margin; arista longer than antenna; frons haired in front, one or two fine short hair-like bristles on upper part of each orbit; inner verticals and the postverticals the best developed of the cephalic bristles. Thoracic bristles weak, the hairs erect and numerous; anterior notopleural minute, posterior one distinct, only one pair of dorsocentrals developed, no acrostichals, two postalars, one supra-alar, and no humeral; propleural and prosternal hairs long; scutellum with some discal hairs and four marginal bristles. Sheath of ovipositor longer than remainder of abdomen, swollen on basal fourth, beyond that forming an almost parallel-sided

cylinder which is slightly tapered at apex, the surface with rather dense fine erect hairs of moderate length. Legs normal, all femora with some fine hair-like ventral bristles, one at base of each much longer than the others. Venation as in Text-fig. 13.

Length, 10 mm.

Type, Cairns, N. Queensland (J. F. Illingworth).

This species is distinguished from *brevicornis* Hendel, a New Guinea species, by the narrow cheek, and the lack of markings on the wings. The wing in the type specimen in certain lights and against a white background shows a very faint grey shade over the entire apex beyond the outer cross-vein, and at level of the stigma there is a similar faint cloud, which it is possible in other specimens may be even more distinct.

Type in United States National Museum.

Nicholsonia, n. gen.

This genus is readily distinguished from its allies by the characters noted in the foregoing key to genera. Wing venation as in Text-fig. 14.

Genotype, *Campylocera curvinervis* Bezzi.

This genus is dedicated to Mr. A. J. Nicholson who collected much of the material which formed the basis of my papers on Australian Diptera.

Adapsilia Waga.

Adapsilia illingworthana Bezzi.

I have before me an additional male of this species which bears a label similar to that of the type specimen. The specimen belongs to the United States National Museum collection.

A NEW SPECIES OF *LYGOSOMA* FROM NEW SOUTH WALES.

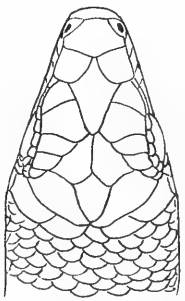
By J. R. Kinghorn, C.M.Z.S., Zoologist, Australian Museum.
(*By permission of the Trustees of the Australian Museum.*)

(One Text-figure.)

[Read 27th March, 1929.]

Lygosoma (Liolepisma) weekesae, n. sp.

Description.—The distance between the end of the snout and the fore limb is contained once and one-third in the distance between the axilla and the groin. Snout short, obtuse. Lower eyelid with a transparent disk which is smaller than the eye but larger than the ear opening; the latter has small but distinct lobules. Nostril pierced in the nasal. No supranasal. Frontal a little shorter than the interparietal and frontoparietals combined, and in contact with the first supraocular. Frontonasal broader than long, forming a straight suture with the rostral and just touching the frontal. The suture between the rostral and the frontonasal narrower than the frontal shield. Four supraoculars, the second much the largest.



Lygosoma (*Liolepisma*) *weekesae*, n. sp.
Holotype, R9745, Australian Museum.
Mt. Kosciusko, 5,500 feet, R. Helms, 1889.

Five or six supraciliaries. Frontoparietals paired, longer than the interparietal. Parietals forming a short suture on the median line. Two pairs of nuchal shields. The scales on the nape and neck are irregularly arranged in 12 to 14 rows between the ears. The sixth or seventh upper labial enters the orbit. There are from 40 to 44 scales round the body, those on the dorsal surface being somewhat irregularly arranged, the dorsals are largest, and the laterals are very much smaller than the ventrals. The scales on the dorsal line are not larger than the adjoining scales. The preanals are only slightly enlarged. The adpressed limbs overlap; the digits are cylindrical, and there are from 20 to 23 lamellae under the fourth toe.

Colour (in spirits).—Brown above, covered with light spots which are arranged in more or less distinct, longitudinal lines. There is a light line from the tip of the snout extending over the eye and along the latero-dorsal area to where it joins its fellow on the base of the tail. Another line extends from the ear to the groin. The underparts are uniformly yellowish-white.

Size.—Holotype, total length, 115 mm.; snout to ear, 11 mm.; width of head, 8 mm.; body, 50 mm.; tail, 65 mm.; fore limb, 17 mm.; hind limb, 20 mm.

Holotype in the Australian Museum, Registered No. R.9745, from Mount Kosciusko, 5,500 feet, collected by R. Helms, May, 1889.

Distribution.—The specimens examined are from the following localities: Two, an adult and young, from 5,500 feet, Mount Kosciusko, collected by R. Helms in May, 1889 (the adult has been made the holotype). One adult from Jenolan, Blue Mountains, collected by R. Etheridge, November, 1895. One adult from Bombala, Snowy Mountains, no other data.

It would appear that this species is restricted to the highlands of New South Wales and Victoria, as Bombala is not very far from the border.

Affinities.—Lygosoma weekesae is more closely related to *L. entrecasteauxi* than to any other species, though the colour and markings suggest *L. pretiosum*, under which name the Museum specimens were registered. *L. pretiosum* is probably restricted to Tasmania and the neighbouring islands, the Australian mainland records evidently having been founded on incorrectly named specimens. The following table will show the characters by which *L. weekesae* has been separated from *L. entrecasteauxi.*

L. weekesae.	*L. entrecasteauxi.*
Scales in 40 to 44 rows.	Scales in 28 to 32 rows.
Ear with distinct lobules.	Ear without lobules.
Two pairs of nuchals.	Three or more pairs of nuchals.
12 to 14 irregular rows of scales between the ears.	8 regular rows of scales between the ears.
Dorsal scales irregular, central row not enlarged.	Dorsal scales regular, central row enlarged.
Rostral forms a straight suture with frontonasal.	Rostral forms a curved suture with frontonasal.

I have named the species after its discoverer, Miss H. Claire Weekes, B.Sc., Linnean Macleay Fellow in Zoology who, while working at the placental structures, called my attention to the wide differences that existed between the New South Wales specimens (thought to be *L. pretiosum*) and the Tasmanian forms.

Note.—Since writing the above, Miss Weekes has been able to secure six additional specimens from the Jenolan District, which have been submitted to me alive. It is pleasing to note that none of them varies in the slightest from my description except as regards colour. The ground colour in life is blackish-brown above and whitish below, while the markings already described are pale chocolate. The iridescent sheen, so common to some other species of *Lygosoma*, is absent in *L. weekesae.*—J.R.K.

ON PLACENTATION IN REPTILES. No. i.

1. Denisonia superba and D. suta; 2. Lygosoma (Liolepisma) weekesae.

By H. Claire Weekes, B.Sc., Linnean Macleay Fellow of the Society in Zoology.

(Plates i-ii; and sixteen Text-figures.)

[Read 27th March, 1929.]

1. Denisonia superba and D. suta.

Introduction.

This communication continues an investigation into reptilian placentation begun in 1925, and is a description of placentation in two venomous ground snakes, *Denisonia superba* and *D. suta*. Hitherto placentation among reptiles has only been described for lizards, and this is the first record of placentation among snakes. At the stages described there is no omphaloplacentation in either snake, since the allantois completely encircles the yolk-sac, but it is possible that omphaloplacentation occurs in earlier stages before the establishment of the allantois beneath the sac.

Three types of allantoplacentation have been recorded among reptiles. The first is that which occurs in the lizards *Chalcides tridactylus* (Giacomini, 1891) and *Lygosoma* (*Liolepisma*) *entrecasteauxi* (Harrison and Weekes, 1925), where the placenta consists of a restricted maternal area of vascular villous ridges lined with enlarged epithelial cells overlying a similarly restricted foetal area which is covered by greatly enlarged chorionic ectoderm cells. The placenta is visible to the unaided eye, after the fixation of the embryos in Bles' solution (1905), as an elliptical opaque area on the dorsal surface of the blastocyst.

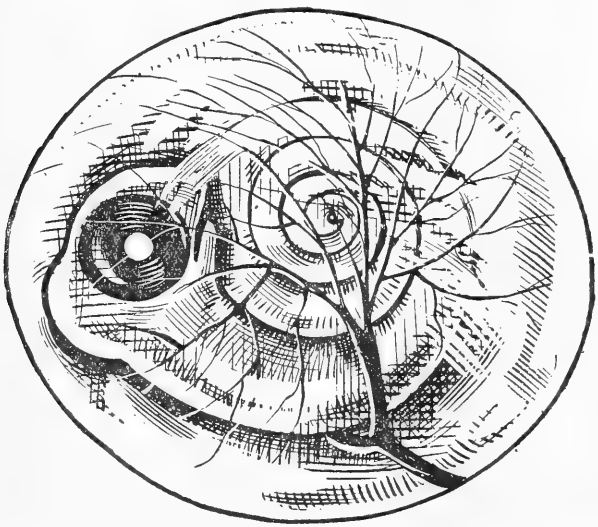
The second type is that described by Flynn (1923) for the lizard *Tiliqua scincoides*, where the placenta is visible only in sectioned material and where, according to Flynn (1923, p. 76), "the union between the chorion and uterine epithelium is very intimate. The uterine epithelium apparently consists of a single layer of very flattened cells, while the chorionic ectoderm has proliferated greatly, is much vacuolated, resembling a typical plasmodium, and is formed, in the main, of markedly enlarged cells with large nuclei and connected together by amoeboid processes".

The third type occurs in the lizard *Lygosoma* (*Hinulia*) *quoyi* (Weekes, 1927) where the placenta extends over the entire surface of the allantois and is visible only in sectioned material, and where the maternal and foetal epithelial tissues partly degenerate so that the maternal and foetal bloodstreams are in close proximity. The placentation of the two snakes somewhat resembles this third type, but has an additional area of vascular villous ridges in the uterine wall, which differ from those hitherto described in any reptile.

DENISONIA SUPERBA.

Material.

The embryos described here were obtained from a "Copper Head" snake, *Denisonia superba*, captured in January, 1926, at Barrington Tops, 150 miles north of Sydney, New South Wales, at a height of approximately 5,000 feet above sea level; and from two snakes collected from Bowral, January, 1928, 82 miles south of Sydney, at a height of approximately 2,210 feet above sea level.



Text-fig. 1.—Embryo coiled on yolk-sac with uterus dissected away; × 4.

The oviducts were removed from the snakes and fixed in Bles' solution. The embryos in the snake collected at Barrington Tops are at a stage of development somewhat similar to that of a four-weeks-old lizard embryo (Text-fig. 1). The embryos in the two snakes collected at Bowral are well developed and I judge them to be within only a few weeks of the time of hatching, so that the stages available give sufficient material for a description of the placentation in this species of snake.

Examination of the uterine wall and foetal membranes was made by means of whole mounts, and examination of the entire embryo and its relationship to its membranes by means of paraffin sections. The yolk-sacs were cut into quarters which, after as much yolk as possible had been removed, were sectioned, so that a complete knowledge of the foetal membranes at the base of the sac was obtained.

Anatomical Relations.

In accordance with the general elongate shape of the body and organs of the parent snake, the majority of the blastocysts are elongate. The "uterus" closely surrounds the blastocyst in the form of the 'incubatory chamber', and the embryo, its membranes and yolk-sac can be seen through the distended uterine wall. The vascularization of the incubatory chamber is fundamentally similar to that surrounding lizard embryos I have examined, there being one main artery and

vein running longitudinally along its dorsal surface, giving off and receiving transverse branch arteries and veins which pass round the blastocyst to the base of the yolk-sac.

The developing embryo is dorsal in position with regard to the parent, lying immediately beneath the main uterine artery and vein. It can be seen lying on the yolk-sac with its body and tail coiled as indicated in Text-figure 1. The blastocysts measure approximately 3·5 cm. in length by 2 cm. in depth by 2 cm. in width. The embryos at the early stage of development measure approximately 7 cm. when extended. The head is well developed, but the scales are only perceptible in the sectioned material and there is no pigmentation. The embryo lies on its left side on the yolk-sac and is sunk down into the sac. The allantoic and yolk-sac stalks are attached by mesenchyme and leave the body of the embryo together about 3 cm. from its posterior end, passing downwards and under the embryo, where they separate. The allantoic stalk then passes directly upwards and expands to form the allantoic vesicle, which is vascularized by two main arteries and one main vein. The vein branches dichotomously and a branch accompanies each of the two arteries. The proximity of artery and vein extends even to the smaller branches of the branch vessels, a peculiarity also found in the vascularization of some mammals.

The right umbilical artery and vein pass across the cavity of the allantois and ramify over the surface of the chorio-allantoic membrane in the dorsal region of the blastocyst. The left umbilical vessels pass over the side of the yolk-sac and ramify through that part of the allantois underlying the sac. Both right and left umbilical vessels drain areas of allantoplacentation. The allantois at this stage has already extended completely round the yolk-sac which is reduced to about half its original size. The vessels pass from the inner to the outer allantoic membrane across the cavity of the allantois in "vascular bridges", as described for the lizard *Lygosoma* (*Hinulia*) *quoyi* (Weekes, 1927), and described below for *Lygosoma* (*Liolepisma*) *weekesae*.

The yolk-sac is supplied with one main artery and vein. The dorsal surface of the yolk-sac is lined by enlarged vacuolated endoderm cells similar to those lining the yolk-sac of the lizard *L. quoyi* (Weekes, 1927). These cells absorb the yolk and pass it to the overlying vessels. The growth of the extra-embryonic mesoderm is modified as in *L. quoyi* where it grows round the yolk-sac embedded in its substance, cutting off from the yolk-sac a layer of tissue which is composed of somatic mesoderm, yolk-sac endoderm and chorionic ectoderm (Text-fig. 6). At this stage in the development of *D. superba* the extra-embryonic coelome beneath the yolk-sac is completely filled by the allantois and the outer allantoic membrane has united with the layers of yolk-sac endoderm and chorionic ectoderm to form a membrane which is composed of allantoic endoderm and mesoderm, somatic mesoderm, yolk-sac endoderm and chorionic ectoderm. The presence of such a membrane was recorded for *L. quoyi* (Weekes, 1927), but the condition here is transitory, the chorionic ectoderm and yolk-sac endoderm being absorbed by the underlying allantoic membrane for the establishment of the type of allantoplacentation peculiar to that lizard. In *D. superba* the membrane is present in the later stage of development available which, as mentioned above, is taken to be near the time of hatching, and, as the membrane forms the foetal portion of an area of placentation and is quite distinct from the chorio-allantoic membrane, it is necessary that it should be given a distinguishing name. The term chorio-omphalo-allantoic membrane is suggested and is used in this paper.

In some blastocysts the embryo is so deeply sunk down into the yolk-sac that it can only be seen by dissecting away the yolk. This peculiarity in position has been recorded for other reptiles, and in lizards, at least, is caused by the growth of a voluminous proamnion which allows the anterior end of the embryo to sink into the yolk-sac in the early stages of development so that it comes to lie beneath the vascular lining of the sac; the posterior end is carried down into the yolk-sac, but it lies outside the vascular lining to the sac and is concealed in a deep depression. When the embryo is so situated the allantoic stalk passes out through the depression in the yolk-sac and expands at its surface.

In the more advanced stages available the embryos are much longer, measuring 16 cm. when extended. The scales are well formed and pigmented and the embryos are capable of movement within their membranes. The yolk-sac is much reduced and is irregular in shape. The vascularization of the allantois and yolk-sac is similar to that described for the earlier stage, the body stalk now leaving the embryo 2 cm. anterior to the anus.

Placentation.

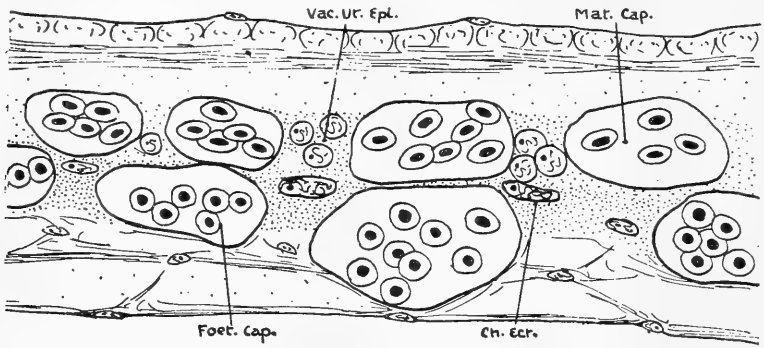
The placenta in *D. superba* is curious in that, at the early stage in hand, it is identical in structure and extent with the mature placenta in *L. quoyi*; whereas at the later stage, when it is mature, an additional restricted area of placentation is present where the uterine wall is extended into ridges round which the foetal tissue is folded.

The uterine wall consists of the tissues usually found in the uterine wall of lizards—the longitudinal and circular muscle coats, the mucosa with scattered glands embedded, and the bounding layer of epithelium. The maternal capillaries are very numerous and enlarged and are exposed at the surface of the uterus with only a thin layer of maternal cytoplasm between them and the underlying foetal tissue. The epithelium is so degenerated that only occasional small round nuclei are present between the exposed capillaries (Plate i, fig. 1).

In the embryonic region the foetal tissue is usually attached to the maternal tissue over the placental face by slightly enlarged chorionic ectoderm cells (Text-fig. 2), or in some areas it may lie closely apposed to the maternal tissues without definite attachment. There is usually no shell membrane present between the two tissues, but in some placentae a trace is discernible. The chorionic ectoderm varies in its degree of specialization over the chorio-allantoic and chorio-omphalo-allantoic membranes. The cells may degenerate so that the foetal capillaries are in contact with the overlying maternal capillaries, they may remain as flat tapering cells, or they may be enlarged to function as absorbers of maternal secretions. The enlarged cells occur irregularly over the placental face and have definite but irregular margins. The cell nuclei are large, oval or round, and stain deeply. The numerous round allantoic capillaries are underlain by a thin layer of muscular tissue bounded by the allantoic endoderm. The inner and outer allantoic membranes are often attached over a considerable area so that the allantoic cavity is obliterated. This junction occurs beneath the yolk-sac in the older stage available (Plate ii, fig. 4).

In the yolk-sac region the foetal tissues differ from those described above. The chorionic ectoderm does not degenerate over any portion of the placental face and may even consist of two or three layers of cells (Plate i, fig. 1). The ectoderm cells are enlarged and rectangular, have a greater breadth than height and,

although they are not uniformly enlarged over the surface of the chorio-omphalo-allantoic membrane, there is more uniformity than exists among the ectoderm cells of the chorio-allantoic membrane. The cell boundaries are definite, the free surfaces of the cells are comparatively regular, and the cell cytoplasm and nuclei stain deeply. The lower layer or layers of ectoderm consist of small flattened



Text-fig. 2.—Section of allantoplacenta of young embryo; × 865. *Ch. Ect.*, chorionic ectoderm; *Foet. Cap.*, foetal capillary; *Mat. Cap.*, maternal capillary; *Vac. Ut. Epi.*, vacuolated uterine epithelium.

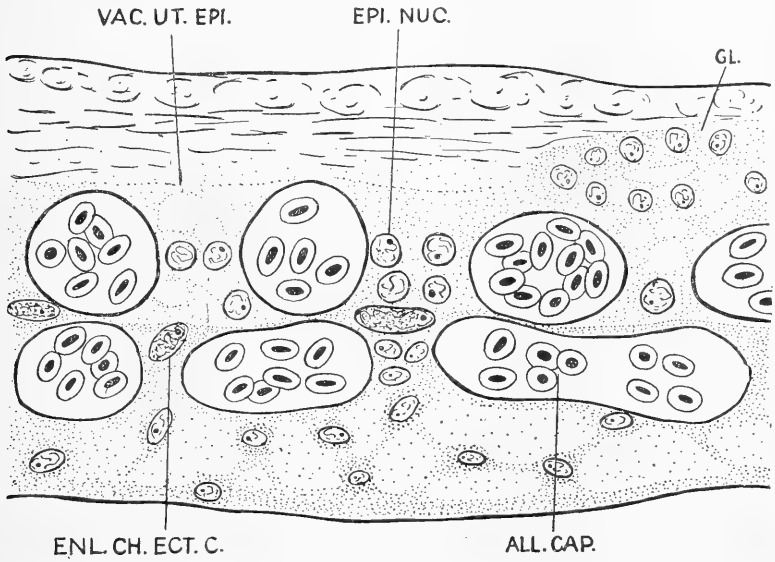
cells. The chorionic cells are either attached or closely applied to the maternal tissue, or they may be separated from it by the remains of the shell membrane and by a colourless coagulum which is probably maternal secretion (Plate i, fig. 1).

The enlargement of the chorionic ectoderm cells in this region suggests the existence of a yolk-sac placenta in earlier stages in the development of the embryo, since all recorded omphaloplacentation for reptiles is characterized by the enlargement of the chorionic ectoderm cells beneath the yolk-sac. A thick layer of yolk-sac endoderm underlies the chorionic ectoderm and its structure corresponds in all respects with that of the endoderm in the chorio-omphalo-allantoic membrane in *L. quoyi*, since it is vacuolated and contains small scattered yolk granules and large irregularly shaped nuclei. The outer allantoic membrane containing the left umbilical artery and vein unites with the mesoderm lining the yolk-sac endoderm, and so this placenta, vascularized as it is by the allantois, is obviously an allantoplacenta in spite of its position immediately beneath the yolk-sac.

From this description and from a comparison of Text-figures 2 and 3 it will be seen that the resemblance between the placentation of *D. superba* at this stage and that of the lizard *L. quoyi* is so striking as to warrant special mention. The modification of the uterine wall in each is identical, since there is the same degeneration of uterine epithelium and exposure of maternal capillaries at the surface of the uterus. Also, in each the foetal tissue is attached to the uterine wall by chorionic ectoderm cells of identical appearance, and the allantoic capillaries lie immediately beneath a thin layer of chorionic ectoderm cytoplasm or are exposed at the surface of the chorio-allantoic membrane.

In the embryos taken from the two snakes collected at Bowral there is an additional area of placentation at the posterior end of the embryo, where the right umbilical vessels pass across the cavity of the allantois.

As mentioned above, this area is only visible in sectioned material. The uterine wall is raised into vascular ridges, round which the foetal tissue is folded. These ridges (Plate i, figs. 2 and 3) vary in shape and are usually filled with capillaries. Many of the capillaries are exposed at the surface of the uterus as in the non-ridged area of placentation, but there is not the same degree of degeneration of the uterine epithelium, there being more nuclei between the capillaries. However, there are few definite cell boundaries. The epithelial cytoplasm is stained deeply by eosin as seen in Figure 3 of Plate i, and this makes it difficult



Text-fig. 3.—Section of the allantoplacental region of a four-weeks old embryo of *L. quoyi*; × 1270. *All. Cap.*, allantoic capillary; *Enl. Ch. Ect. C.*, enlarged chorionic ectoderm cell; *Epi. Nuc.*, epithelial nuclei; *Gl.*, gland; *Vac. Ut. Epi.*, vacuolated uterine epithelium.

to obtain a good photomicrograph. Glands are also present in the vicinity of the ridges, but they are obviously not functioning since they are compressed, with the cell nuclei arranged in a flat ring of vacuolated cytoplasm.

The attachment of the foetal tissue to the maternal tissue is brought about by the insinuation of protoplasmic processes of the chorionic ectoderm cells into the uterine wall as in the non-ridged area. It is of interest that the histological structure of the two regions is similar except that in the ridged area there is a more definite layer of uterine epithelium. Where the maternal and foetal tissues are torn apart there is a thin coagulum between them and the cytoplasm of the chorionic ectoderm cells is jagged and torn. When sectioning it is impossible to avoid cutting some of the ridges obliquely, and this accounts for the blurred appearance of the ridges at the centre of Figure 2 of Plate i.

Denisonia suta.

For the material described here I have to thank Mr. J. R. Kinghorn, C.M.Z.S., of the Australian Museum, Sydney, who gave me three of the six embryos

extracted by him from a specimen of *Denisonia suta* which was collected by Mr. Froggatt at Willow Tree, New South Wales, and presented by him to the Museum. It may be as well to recall here that Mr. Kinghorn in his "Studies in Australian Reptiles" (*Rec. Aust. Mus.*, 1920) has referred *D. suta*, *D. frontalis* and *D. stirlingi* to the one species *Denisonia suta*.

The embryos are in an advanced stage of development similar to that of the older embryos of *D. superba* described above. As in *D. superba* the blastocysts are long and comparatively narrow, each measuring approximately 3 cm. in length and the contained embryo, when extended, approximately 15 cm. The yolk-sac is reduced to a small flat sac at the side of the blastocyst and is completely surrounded by the allantois. Since the oviducts containing the young had been removed from the snake, it is impossible to discuss the relative positions of the embryos and the parent, but it seems justifiable to deduce that the dorsal surface of the blastocyst is that underlying the main longitudinal uterine vessels, assuming that the position of the vessels in *D. suta* is similar to that of the vessels in *D. superba* and all lizards examined.

The embryos were removed from their membranes and the membranes, after examination through the binocular microscope, were sectioned. The sections were stained with carmalum or with Delafield's haematoxylin using eosin as the counterstain.

The vascularization of the uterus is similar to that in *D. superba*, the main longitudinal artery and vein giving off and receiving branch vessels which pass round the incubatory chamber to the base of the yolk-sac. The vascularization of the allantois and the yolk-sac also corresponds with that in *D. superba*.

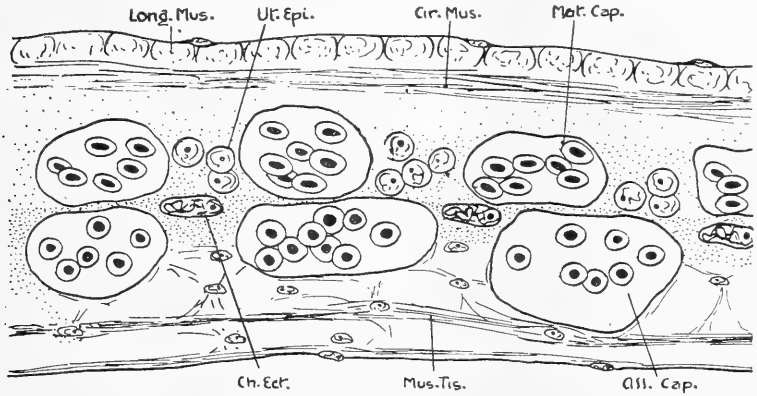
At this stage there are the two distinct regions of placentation, the ridged and the non-ridged regions. The ridged area is situated at the anterior end of the blastocyst, is dorso-lateral in position, and measures approximately 1·2 cm. in length and 0·8 cm. in width. The embryos were not fixed for sectioning and as a result of indifferent fixation there is considerable shrinkage of the tissues and in the ridged area of placentation the maternal and foetal tissues are separated. However, the general form and histological structure of the placenta is clear. The placentation, both in the ridged and non-ridged regions, is so similar to that in *D. superba* that there is no need for a further description. Surrounding the foetal ridges there is a considerable quantity of coagulum, some of which is taken to be the remains of the shell membrane. Maternal and foetal ridges are shown in figure 5 of Plate ii.

Comparison with the Lizards Lygosoma (Liolepisma) entrecasteauxi and Lygosoma (Hinulia) quoyi.

The presence of a restricted placental area of special modification in *D. superba* and *D. suta* recalls the placentation of the lizard *Lygosoma* (*Liolepisma*) *entrecasteauxi* where, over an elliptical area on the dorsal surface of the blastocyst, the internal face of the uterine wall is raised up into a series of villous ridges. It is also of interest that the structure of the non-ridged placental region in the two snakes is, in all essentials, similar to that of the same region in the lizard (Text-fig. 4). However, there are many differences in the position, form and histological structure of the ridged areas of placentation in the lizard and the two snakes. In *L. entrecasteauxi* the ridged area is dorsal in position and extends from one end of the blastocyst to the other; it can be seen with the unaided eye;

the ridges are numerous, rounded and implicate, and are lined by enlarged, cubical, ciliated epithelial cells. The chorionic ectoderm cells lining the underlying foetal tissue are greatly enlarged and ciliated. In *D. superba* and *D. suta*, it will be recalled, there is no special modification in the histological structure of the tissues concerned.

The placentation of the lizard *Lygosoma* (*Hinulia*) *quoyi* (Text-fig. 3) so resembles that in the non-ridged region of *D. superba* and *D. suta* that it is impossible to distinguish between them. There is the same degeneration of uterine and chorionic epithelium and exposure of maternal and foetal capillaries at the surface of the uterus and the chorio-allantoic membrane. The main discernible



Text-fig. 4.—Section of non-ridged region of allantoplacentation in *L. entrecasteauxi*; × 865. *All. Cap.*, allantoic capillary; *Ch. Ect.*, chorionic ectoderm; *Long. Mus.*, longitudinal muscle; *Mat. Cap.*, maternal capillary; *Mus. Tis.*, muscle tissue; *Ut. Epi.*, uterine epithelium.

difference is that, in *L. quoyi*, with the gradual extension of the allantois beneath the yolk-sac and the consequent formation of the chorio-omphalo-allantoic membrane, the yolk-sac endoderm is gradually absorbed by the underlying allantoic blood-vessels, and with the further degeneration of the chorionic ectoderm, the allantoic capillaries come to lie at the surface of the foetal tissue. In *D. superba* and *D. suta*, however, the allantois completely surrounds the yolk-sac at a comparatively early stage and the yolk-sac endoderm in the chorio-omphalo-allantoic membrane does not disappear, both it and the chorionic ectoderm being well defined at the late stage available (Plate ii, fig. 4).

Summary.

This communication records placentation among snakes for the first time, but since the great majority of the venomous snakes of Australia at least are viviparous, it is possible that an investigation of them will reveal that the occurrence of placentation among snakes is not uncommon.

The following is a summary of the chief facts observed:

1. Allantoplacentation is recorded for the two snakes *Denisonia superba* and *D. suta*.

2. There is a remnant of shell membrane surrounding the blastocysts in both snakes at the stages described, so the snakes are not strictly viviparous.

3. There is no omphaloplacenta present in either snake since the allantois extends beneath the yolk-sac at a comparatively early stage in the development of the embryo.

4. In both snakes the extra-embryonic mesoderm grows into the yolk-sac and cuts off a layer of yolk-sac endoderm, so that the extra-embryonic coelome lies within the yolk-sac and a "chorion" is formed consisting of ectoderm, yolk-sac endoderm and mesoderm. The term chorio-omphalo-allantoic membrane is suggested for the membrane formed by the junction of the outer allantoic membrane with this "chorion."

5. The placentation in the two species of snake is identical, and occurs over the entire surface of the allantois. The placenta consists of a maternal wall, with the lining epithelial cells partially degenerated and the capillaries enlarged and exposed at its surface. The maternal wall overlies a well vascularized chorio-allantoic or chorio-omphalo-allantoic membrane with capillaries also exposed at the surface, so that the maternal and foetal bloodstreams are in close proximity. The foetal tissue is attached to the maternal wall by slightly enlarged, scattered chorionic ectoderm cells. The placental face is smooth over its main extent, but over a comparatively small area, dorso-lateral in position, at the posterior end of the blastocyst the internal face of the maternal wall is raised up into vascular villous ridges round which the foetal tissue is folded.

6. The structure of the non-ridged placental region is identical with that of the allantoplacenta in the lizard *Lygosoma* (*Hinulia*) *quoyi*, and with that of the non-ridged placental region in *Lygosoma* (*Liolepisma*) *entrecasteauxi*.

2. Lygosoma (Liolepisma) weekesae.

Introduction.

After a comparative study of the placentation of *Lygosoma* (*Hinulia*) *quoyi* and *Lygosoma* (*Liolepisma*) *entrecasteauxi*, which revealed outstanding differences in the two types of allantoplacentae, the placentation of *Lygosoma* (*Liolepisma*) *weekesae* (Kinghorn, 1929) was naturally investigated with much interest, as *L. weekesae* and *L. entrecasteauxi* belong to the same subgenus *Liolepisma*. The result of the investigation was gratifying as it showed that, although the two species have allantoplacentae of a fundamentally similar type, there are most interesting points of difference which, to my mind, strengthen the evidence for the independent evolution of the placenta in different groups of related animals. This aspect is discussed below with the theoretical considerations.

L. weekesae is recorded only from the Jenolan and Kosciusko districts in New South Wales and *L. entrecasteauxi* is also recorded from the same districts. The habitat of the two lizards ranges from 3,000 to 4,000 feet above sea level and is above the winter and late spring snow line. As yet our knowledge of the distribution of lizards in Australia is incomplete and records from mountain regions are particularly scarce. I have visited five of the high plateau regions in Eastern Australia and Tasmania and on each the number of viviparous species of lizard outnumbered the oviparous; viviparity offers obvious advantages when it is realized that at the time of the fertilization of the ova and sometimes well on in the breeding season the ground in these plateau regions is often covered with snow. At Barrington Tops the lizards most common were *L. entrecasteauxi* and

L. quoyi, for both of which placentation has been described, while *Tiliqua scincoides*, the viviparous blue-tongue, was also found. The only oviparous species observed was *Amphibolurus muricatus* and there were but few of these. At Mt. Kosciusko exactly the same condition existed, where ninety specimens of *L. entrecasteauxi* and *L. quoyi* were collected and only one specimen of *Amphibolurus muricatus* was found. In the Jenolan district the preponderance of viviparous species was even more marked, since eight of the ten species collected were viviparous. Although the oviparous species appear to be more or less restricted to lower levels, many of the viviparous lizards flourish at all altitudes, *T. scincoides*, *Egernia whitei*, *E. cunninghami* and *E. striolata*, *Lygosoma* (*Hemiergis*) *decresiensis* and *L. quoyi* having been collected in large numbers in coastal districts little above sea-level.

The description of the placentation of *L. weekesae* is important because it is a step further in the comparative study of placentation among reptiles, which, to my mind, will lead to a clearer understanding of the facts of placentation and will delimit the extent to which the existence of an allantoplacenta may justifiably be used as a phylogenetic argument.

Material.

The material at my disposal comprises thirty-two specimens of *L. weekesae* containing young collected at Jenolan, 120 miles west of Sydney, at a height of approximately 4,000 feet above sea level. These were all collected on 1st December, 1927. Some were preserved on that date, while the remainder were taken to Sydney and kept alive, a few being killed every three or four days. The last lizard was opened on 30th January, 1928. The breeding season is a fairly regular one since there was little difference between the stages of development of the embryos obtained from the various females collected on 1st December. It is impossible to give the exact age of the embryos contained in these lizards, since the time of the fertilization of the ova is not known. The embryos were at a stage of development similar to that of the embryos of females of *L. entrecasteauxi* collected from the same locality on the same day, and which were judged to be approximately two weeks old after comparison with two-weeks-old embryos of that species collected at Mt. Kosciusko in November, 1926.

This description of placentation in *L. weekesae* covers a period of approximately eight weeks. In the embryos of the lizards collected on 1st December, the chorio-allantoic membrane is but recently established, and the modification of maternal and foetal tissues for allantoplacentation is at an early and interesting stage. The placentation of the embryos obtained from lizards opened on and about 14th December is considered mature, since there is no appreciable advance in development in the placentae of embryos collected during the ensuing weeks up till the end of January. The lizards opened on 30th January were in an advanced stage of pregnancy, the young being well pigmented and capable of movement within their membranes.

Examination was made by means of whole mounts of both the maternal and foetal placentae, and by means of paraffin sections of the placental area and of the whole uterine sac with its contained embryo, the sections being taken transversely to the long axis of both oviduct and foetus.

Preparations were stained with carmalum or with Delafield's haematoxylin using eosin as a counterstain.

Placentation.

Four stages in the development of the placenta are described. Stage A presents the early development in embryos preserved on 1st December; Stage B, the development in embryos preserved during the first week of December; Stage C, the development in embryos preserved at the beginning of the second week of December; and Stage D, the stage of placental maturity, covering the six weeks from the end of the second week in December till 30th January.

STAGE A.

Anatomical Relations.

Eight females were preserved in Bles' solution on 1st December and they each contained from three to five young. In each lizard there was one more embryo in the right oviduct than in the left and this arrangement of the embryos was constant in all except four of the lizards examined. An explanation of this arrangement, which is also common in *L. entrecasteauxi* and *L. quoyi*, was suggested in a previous paper (Weekes, 1927*a*, p. 506) where it was stated that the arrangement may be determined by the position of the stomach of the lizard, which is always found to be on the left side and closely pressed against the left ovary, thus possibly interfering with the number of ova developing in this ovary.

The embryos within their membranes cause the oviducts to exhibit a series of moniliform swellings closely adpressed end to end and connected each to each by a short strap-like section of the oviduct. These expansions of the oviduct were called "incubatory chambers" by Giacomini (1891). As in *L. entrecasteauxi* and *L. quoyi*, when the parent lies upon its back with the ventral body wall opened up and the uteri exposed, the yolk-sacs of the contained embryos are visible as yellow, vascularized areas, ventral in position. It is necessary to lift aside the body wall of the parent to see the underlying embryos, which are dorsal in position with regard to the parent. The allantoic vesicle of each embryo is filled with a clear fluid which, together with the transparent uterus and foetal membranes, enables the embryo to be clearly seen lying on the yolk-sac. The maternal allantoplacental region shows up as an opaque elliptical patch extending from the anterior to the posterior end of the incubatory chamber. There are two regions of allantoplacentation in *L. weekesae* as in *L. entrecasteauxi* (Weekes, 1927*a*, p. 548). The area of apposed maternal and foetal tissues other than the omphaloplacental and elliptical allantoplacental areas is also placental.

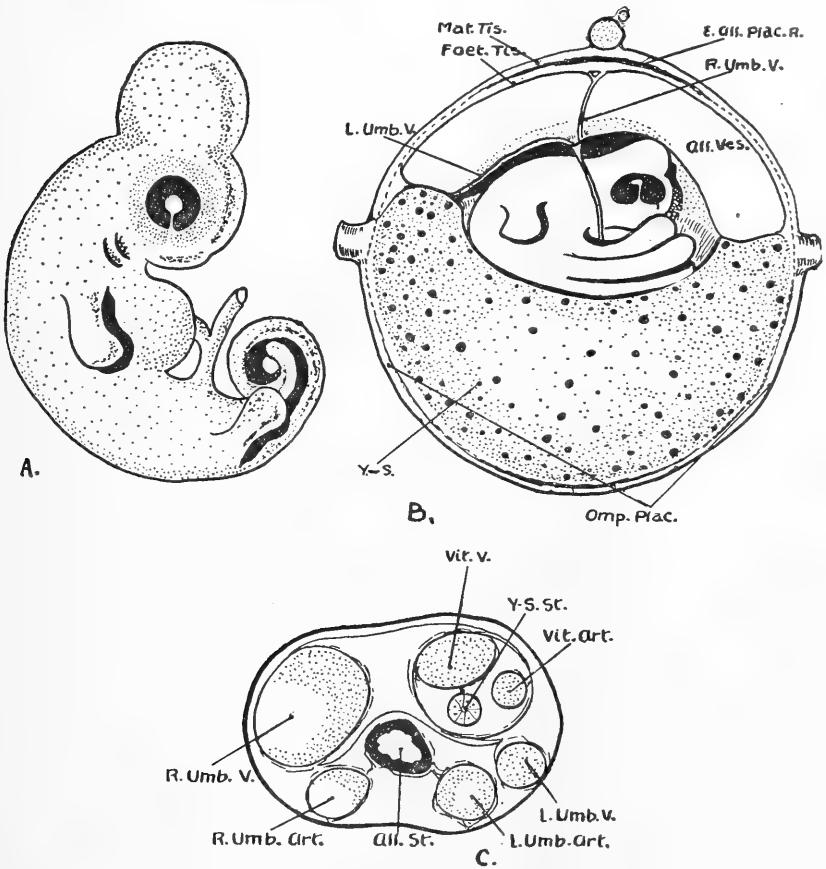
The embryo lies with its long axis parallel to that of the parent. Text-figure 5, A, shows the development of the embryo at this stage. On dissecting away the uterine wall and disclosing the foetus lying within its membranes the allantoic stalk is seen to pass directly upwards and to expand immediately above the embryo into the allantoic vesicle. The allantoic vesicle does not extend beneath the yolk-sac, so that the sac is covered externally by the serosa. The yolk-sac at this stage occupies approximately two-thirds of the blastocyst, and the allantoic vesicle and the embryo the remainder. The yolk-sac stalk extends to meet the allantoic stalk in a common body stalk which enters the embryo close to the mid-line of the body a short distance in front of the hind limbs. Text-figure 5, B, shows the relationship between the embryo, its allantoic vesicle and its yolk-sac.

The amnion is a delicate membrane which unites with the inner allantoic membrane over part of its extent. There is no trace of egg shell, although in the earliest stages of development available there is a slight trace of shell membrane

which appears as debris at the base of the yolk-sac. The lizard is therefore not strictly viviparous, but the amount of shell membrane present is much less than in *L. quoyi* and is so small as to be negligible.

The Placentae.

The uterus is vascularized by one main longitudinal artery and vein running along its dorsal surface and hence along the dorsal surface of each incubatory chamber. The artery supplies branch vessels which pass transversely round each



Text-fig. 5.—A, Embryo at Stage A, × 10·5; B, section through blastocyst at Stage A showing position of embryo on yolk-sac; passage of umbilical vessels across the allantoic cavity and round the inner allantoic membrane, and the relative positions of omphaloplacenta and allantoplacenta, × 9; C, section through umbilical stalk at Stage A, × 96. *All. St.*, allantoic stalk; *All. Ves.*, allantoic vesicle; *Foet. Tis.*, foetal tissue; *L. Umb. Art.*, left umbilical artery; *L. Umb. V.*, left umbilical vein; *Mat. Tis.*, maternal tissue; *Omp. Plac.*, omphaloplacenta; *R. Umb. Art.*, right umbilical artery; *R. Umb. V.*, right umbilical vein; *Vit. Art.*, vitelline artery; *Vit. V.*, vitelline vein; *Y-S.*, yolk-sac.

incubatory chamber to the base of the yolk-sac. The vein receives similar transverse branches which, as in *L. entrecasteauxi* and *L. quoyi*, roughly alternate with the branch arteries.

L. weekesae possesses both an omphaloplacenta and an allantoplacenta. At this stage the omphaloplacenta is comparatively well developed and, as in *L. quoyi*, functions best during the early development of the embryo before the allantoplacenta becomes mature. The entire region of the uterus embraced by the chorioallantoic membrane is modified for allantoplacentation which explains the presence of an extraordinarily rich capillary network over the uterine wall.

The maternal portion of the specialized elliptical area of allantoplacentation on the dorsal surface of the incubatory chamber is vascularized by short branch vessels from the main artery and vein as in *L. entrecasteauxi*. The nature of the vascularization of the uterine wall is clearly shown in Text-figure 11 and figure 7 of Plate ii. The allantoic vesicle at this stage is vascularized by two main arteries and two main veins. Text-figure 5, C, shows the position of the vessels in the allantoic stalk, an artery and vein being carried in the mesenchyme on either side of the stalk. The right umbilical artery and vein pass from the inner to the outer allantoic membrane across the cavity of the allantois in the manner described below at Stage D, and drain the allantoplacenta in the dorsal region of the blastocyst, particularly the specialized elliptical area. The left umbilical artery and vein pass down and round the posterior end of the embryo in the mesenchyme lining of the inner allantoic membrane as described for *L. quoyi* and illustrated in Text-figure 5, B.

The yolk-sac is vascularized by one main artery and vein which ramify through the mesenchyme lining the sac.

Within the body of the embryo the vitelline artery joins the dorsal aorta a little anterior to the junction of the umbilical arteries and the aorta. Both umbilical veins and the vitelline vein enter the liver and there join with the intrahepatic vessels and with the ductus venosus.

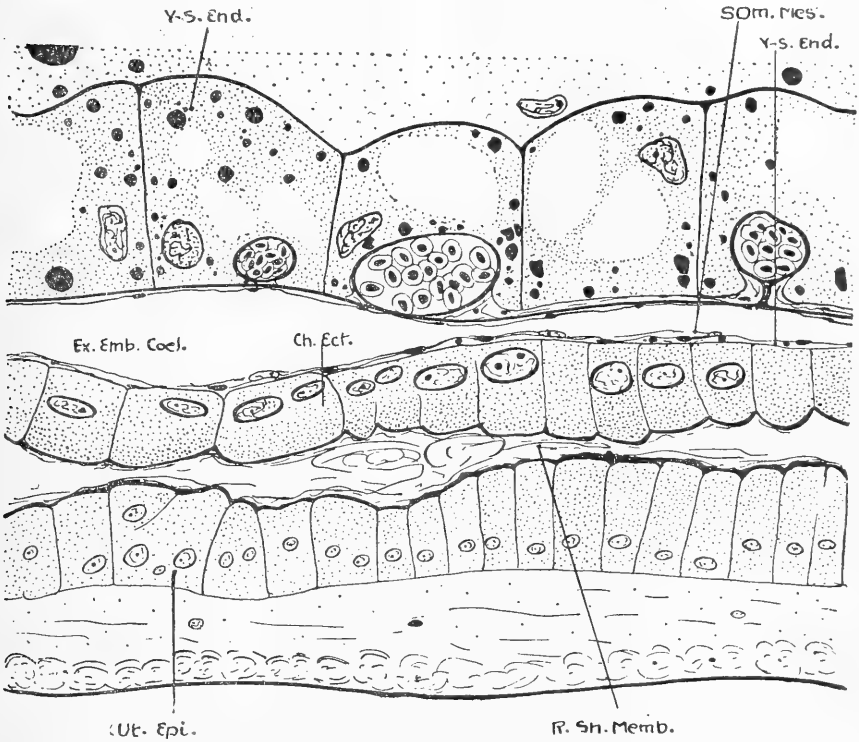
Omphaloplacentation.—The entire uterine wall surrounding the yolk-sac is modified for omphaloplacentation, but there is very little modification of the foetal tissue. The cells of the uterine epithelium are enlarged, columnar and comparatively narrow, with a large round nucleus at the base. In section the outline of the free surface of the epithelium is uneven, the irregularities fitting into those of the foetal tissue. The epithelium is not ciliated. Remains of some shell membrane are present between the maternal and foetal tissues, but otherwise there is little coagulum.

The cells of the chorionic ectoderm are enlarged at the sides of the yolk-sac but not at the base. The growth of the extra-embryonic mesoderm round the yolk-sac is irregular, as described above for *Denisonia superba*, so that the chorionic ectoderm is underlain by a layer of yolk-sac endoderm and somatic mesoderm, and the extra-embryonic coelome lies within the yolk-sac (Text-fig. 6).

Allantoplacentation.—The elliptical allantoplacental region can just be recognized as a faintly opaque area. The opacity is due to the internal face of the uterus being raised into villous ridges, which at this stage are not deep and are seen best in sectioned material. The ridged maternal area is immediately underlain by an area of specialized foetal tissue similar in shape and extent.

The uterine wall consists of an external layer of peritoneum; a muscular coat consisting of an outer coat of longitudinal muscle and an inner coat of circular

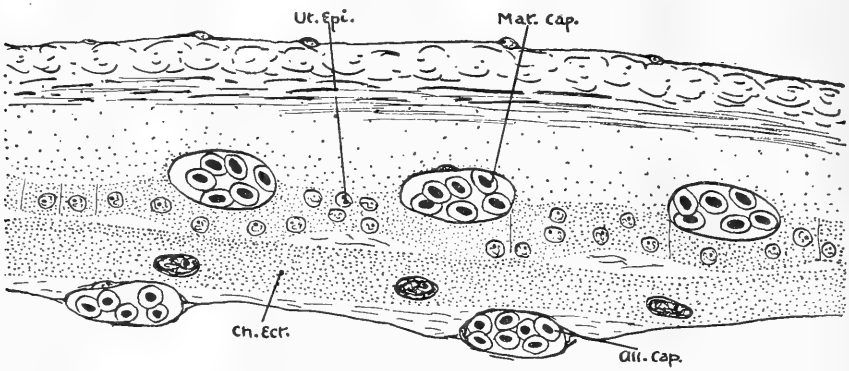
muscle; the mucosa, containing flattened non-functioning glands and numerous blood-vessels and capillaries; and finally the epithelium. The capillaries are round and enlarged and appear to invade the underlying epithelium. The epithelium does not degenerate, although there is a certain amount of thinning over the bulging capillaries and an absence of definite cell formation (Text-fig. 7). The bulging of the capillaries at the surface of the placental face is the first stage in the development of vascular villous ridges.



Text-fig. 6.—Section of omphaloplacenta, Stage A, × 640. *Ch. Ect.*, chorionic ectoderm; *Ex. Emb. Coel.*, extra-embryonic coelome; *R. Sh. Memb.*, remains of shell membrane; *Som. Mes.*, somatic mesoderm; *Ut. Epi.*, uterine epithelium; *Y-S. End.*, yolk-sac endoderm.

The foetal tissue is closely apposed to the overlying maternal tissues but the development of the villous ridges in the maternal wall leads to a gentle pushing apart of the two placental faces and the formation of gaps between them which are filled by a colourless coagulum, probably maternal secretion. There is no trace of shell membrane. Neither the maternal nor foetal placental face is ciliated. The chorionic ectoderm cells are enlarged but are much wider than they are high, and some occur which are about five times as wide as high and are obviously the normal flat tapering cells of the chorionic ectoderm undergoing the process of enlargement. The cell boundaries are not as definite as at later stages. The cell cytoplasm is densely granular and shows little sign of vacuolation. The underlying

allantoic capillaries are flat but numerous, with definite endothelial walls, and are embedded in a thin band of mesenchymatous tissue. There is little muscular tissue in the mesenchyme.



Text-fig. 7.—Section of allantoplacenta in an early stage of development; × 450. *All. Cap.*, allantoic capillary; *Ch. Ect.*, chorionic ectoderm; *Mat. Cap.*, maternal capillary; *Ut. Epi.*, uterine epithelium.

The non-ridged area of placentation is not extensive since the yolk-sac is large and fills the greater part of the incubatory chamber, and the elliptical allantoplacental region is comparatively wide. However, as the embryo grows and the yolk-sac decreases in size this region increases in extent and becomes an important area of placentation. The foetal tissue is attached to the maternal tissue in this non-ridged region. The maternal capillaries appear to invade the uterine epithelium as in the ridged region, but the epithelial cells are more degenerated, and in some cases the capillaries are exposed at the surface of the placental face. The chorionic cells are not enlarged but taper over the allantoic capillaries, which contain young round corpuscles, easily distinguishable from the oblong maternal corpuscles. There is little mesenchymatous or muscular tissue underlying the capillaries. From this description and from reference to the placentation of *L. quoyi* (Weekes, 1927), it will be seen that the structure of this region resembles that of the allantoplacenta of *L. quoyi* at a corresponding stage in development and, as might be expected, in later stages of development the similarity in the two types of placentation persists.

Stage B.

Anatomical Relations.

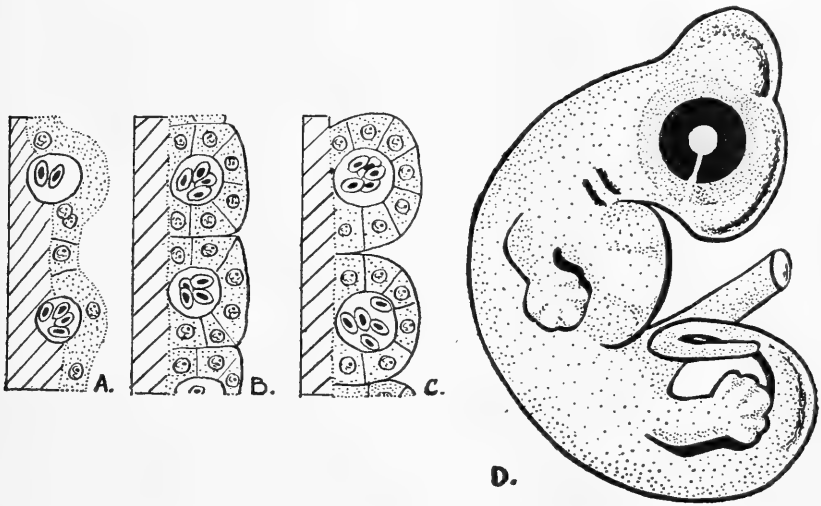
Five females were preserved during the first week in December. There is no outstanding development in the anatomical structure of the foetus or in the vascularization of the uterus and foetus. The allantoic vesicle is larger and the yolk-sac a little smaller. The embryo is larger and there is an indication of digits on both fore and hind limbs (Text-fig. 8, D).

The Placentae.

There is no apparent difference between the structure of the omphaloplacenta at this stage and that at Stage A.

Allantoplacentation.—The elliptical allantoplacental area is slightly more prominent than at Stage A, since the villous ridges project further beneath the

surface of the uterus and the epithelium over the bulging capillaries is thicker. The epithelial nuclei are large and stain lightly and are typical of the uterine epithelial nuclei in all lizards examined. They have proliferated and there is a tendency towards definite cell formation. The cells, although larger than at Stage A, are not enlarged, but have only regained their original structure which was altered by the invasion of the maternal capillaries. A few of the cells are



Text-fig. 8.—A, B and C, diagrammatic representations of three stages in the formation of the vascular villous ridges, × 300; D, embryo at Stage B, × 10·5.

ciliated. The bulging of the capillaries at the surface of the uterus and the proliferation of the epithelial nuclei and the regeneration of the epithelial cells lead to the formation of the villous ridges and crypts as indicated in Text-figure 8. At this stage the condition shown in Text-figure 8, B, is often met with; the condition in Text-figure 8, C, is more uncommon.

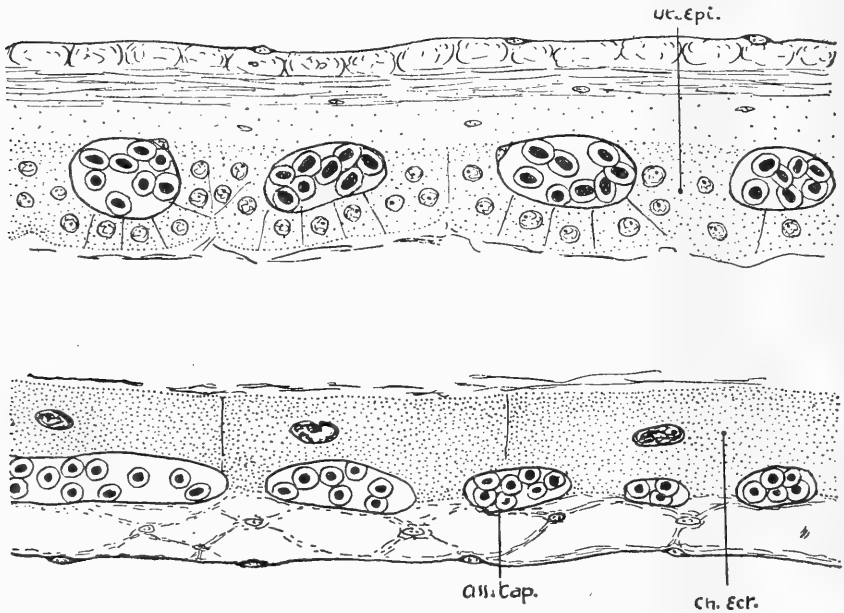
The foetal tissue is still separated from the maternal tissue. The cells of the chorionic ectoderm are taller and narrower than at Stage A and are now about twice as long as they are high. They have obviously proliferated and, although no mitotic figures were observed, many pairs of nuclei were found lying side by side, which suggests that division had taken place. There is no trace of ciliation of the cells. The allantoic capillaries are more numerous than at Stage A and they push against the base of the overlying chorionic ectoderm cells until they appear to be almost embedded in the substance of the cells, a column of chorionic cytoplasm separating the capillaries from each other (Text-fig. 9). The capillaries are underlain by a comparatively thick band of mesenchymatous tissue with muscle fibres embedded. The endodermal lining to the foetal tissue consists of a distinct layer of flat tapering cells.

In the non-ridged region of placentation the capillaries have almost reached the surface of the uterus, although in places the original uterine epithelium persists. The chorionic ectoderm cells are somewhat flatter than at Stage A and the allantoic capillaries consequently nearer the surface of the foetal tissue.

Stage C.

Seven females were preserved during the second week of December. The embryos contained are larger than those preserved during the first week and each yolk-sac is reduced to about half the size of the blastocyst. There is no further modification of the maternal and foetal vascularization, or of the omphaloplacenta.

Allantoplacentation.—The villous ridges of the elliptical placental region are deeper than at Stage B, as illustrated in Text-figure 8, C, so that there are now definite crypts between the ridges. The epithelium lining the ridges is definitely cellular and some of the cells are ciliated. The epithelial cells are slightly enlarged and in some places are flattened at their free margins where they are pressed against the underlying foetal tissue.



Text-fig. 9.—Section of elliptical allantoplacental region at Stage B, × 450. *All. Cap.*, allantoic capillary; *Ch. Ect.*, chorionic ectoderm; *Ut. Epi.*, uterine epithelium.

The cells of the chorionic ectoderm are still further enlarged, so that they are now as tall as they are wide and comprise about two-thirds of the thickness of the foetal tissue. They each contain a large, deeply staining nucleus at the base and a few of them are ciliated (Text-fig. 10).

There is no noticeable alteration in the structure of the non-ridged region at this stage.

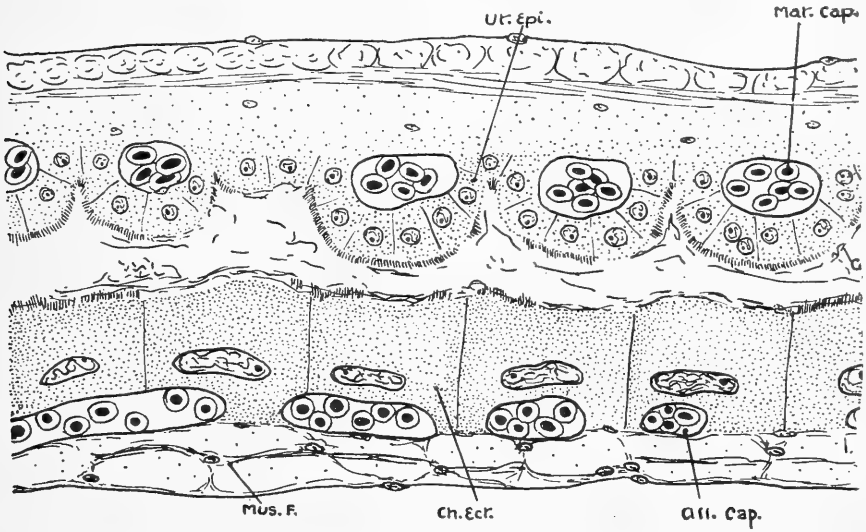
Stage D. Placental Maturity.

Anatomical Relations.

Altogether twelve lizards were preserved from the beginning of the third week in December, 1927, to the 30th January, 1928, and each contained from three to seven young. At the beginning of this period the placentae have reached maturity and the embryos show a slight advance in development over those described at

Stage C, but since the advance is naturally more marked in embryos examined during January, a late stage will be described here.

When one of the lizards opened on 30th January lies upon its back with the ventral body wall opened up, the yolk-sacs show as creamy yellow areas mesolateral in position and much reduced in size, so that the underlying embryos are clearly visible. At this stage there is very little yolk left within the yolk-sac.



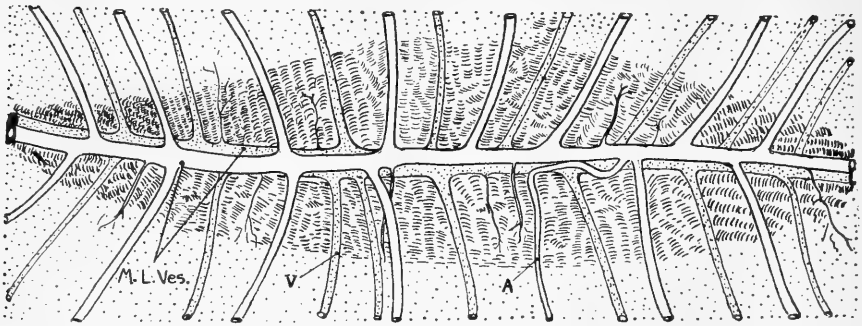
Text-fig. 10.—Section of elliptical allantoplacental region at Stage C, × 450. *All. Cap.*, allantoic capillary; *Ch. Ect.*, chorionic ectoderm; *Mat. Cap.*, maternal capillary; *Mus. F.*, muscle fibres; *Ut. Epi.*, uterine epithelium.

The incubatory chambers measure approximately 9 mm. by 7 mm., and the embryos, when extended, measure from 3 to 3·5 cm. The scale markings are pronounced and the embryos are capable of movement within their membranes. The embryo lies on its left side on the yolk-sac with its head overlying the posterior end of the body and directed mesially whether the embryo is in the right oviduct or in the left. The long axis of the embryo is parallel to that of the parent lizard.

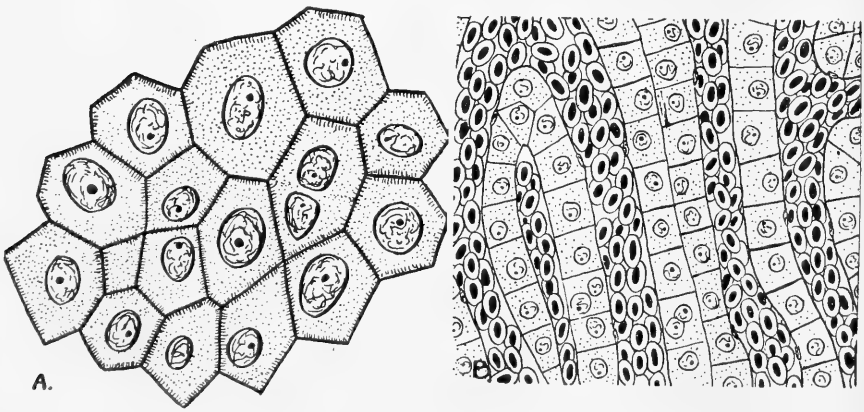
The Placentae.

With the growth of the embryos the incubatory chambers become more closely adpressed. On the dorsal surface of each incubatory chamber the elliptical allantoplacental area is markedly opaque and thus clearly visible. The main uterine artery and vein run longitudinally along the approximate mid-line of the placental area and with their branch vessels are also opaque and hence prominent. When the uterus is stained with haematoxylin and viewed through the binocular microscope the villous ridges are seen to be very numerous and small. The whole placental area has somewhat the appearance of a lanceolate leaf with its network of veins (Text-fig. 11; Plate ii, fig. 7). The netted appearance of the ridges is due to the fact that the ridges are not prominent but are simple in structure and only project a short distance below the uterine face, each containing a single blood

vessel which does not branch. The direction of the ridges is not obvious, as it is in *L. entrecasteauxi*, but there is a general tendency towards a transverse direction across the incubatory chamber, while the ridges are definitely longitudinal at the ends of the chamber where the uterus narrows into the strap-like connection. The placental area measures 9 mm. in length by 3 mm. in width.



Text-fig. 11.—Elliptical region of allantoplacentation of uterine wall viewed as a transparent object, × 15. *A.*, artery; *M. L. Ves.*, main longitudinal vessels; *V.*, vein.



Text-fig. 12.—A, chorionic ectoderm cells of elliptical placental region in surface view, × 320; B, villous ridges of uterine wall in surface view, × 385.

Text-figure 12, B, shows the villous ridges in surface view. The channels in the ridges are composed solely of blood vessels with their thin endothelial walls. Text-figure 13, B, shows a portion of the non-ridged region in surface view, with the vessels ramifying through the flat epithelium. There is no lining of uterine epithelium to the capillaries, the epithelium being restricted to the regions between the capillaries, where the walls of the epithelial cells are more distinct in surface view than in sectioned material.

As mentioned above the elliptical placental area is supplied with short branch arteries and veins from the main longitudinal artery and vein and over the rest

of the uterus there is a rich capillary network. The transverse branch arteries and veins pass right round the incubatory chamber to the yolk-sac, but with the enlargement of the allantoic vesicle, the reduction of the yolk-sac, and the consequent extension of allantoplacentation, the omphaloplacental region decreases in size and importance.

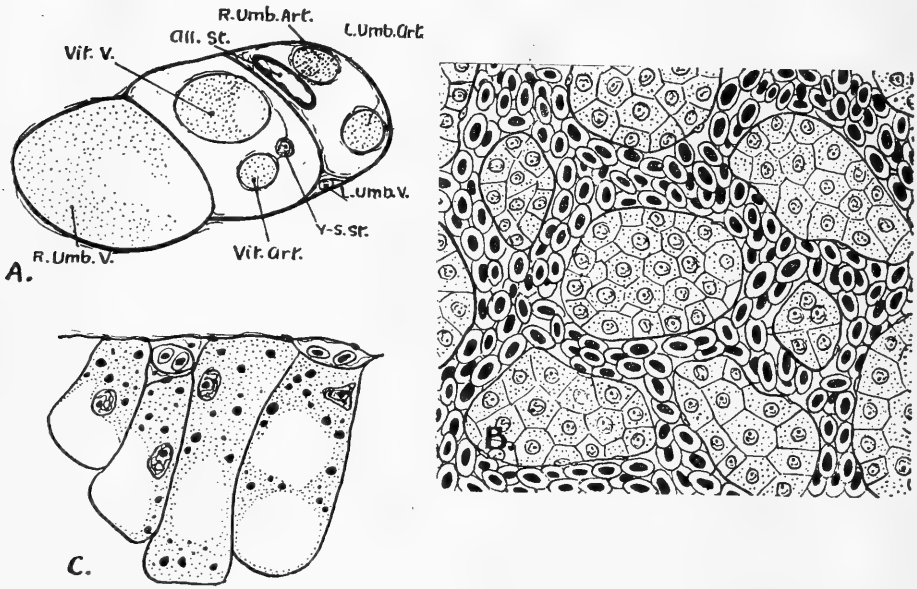
The allantois is richly vascularized and the right umbilical vessels are important as they drain most of the allantoplacental region. They pass from the inner to the outer allantoic membrane across the cavity of the allantois and in one embryo a pleated fold arose from the inner allantoic wall within the free edge of which the vessels were carried. The occurrence of such a pleat was common in *L. entrecasteauxi* but, as the stage described in the development of *L. entrecasteauxi* was advanced, it was impossible to deduce the origin of the pleat. In the description of the placentation of *L. quoyi*, many early stages were available and the origin of the pleat was discovered. It was stated in this paper (Weekes, 1927*a*, p. 525) that "the position of the blood vessels in the allantoic vesicle in *L. quoyi* is due to the comparatively rapidly growing wall of the vesicle enfolding the more slowly growing blood vessels present in its mesenchyme. The arms of the folds from either side meet, and thus separate the vessels from the rest of the vesicle wall except for a pleat-like connection which may remain helping to hold the suspended vessels in position. Such a pleat may evidently persist in *L. entrecasteauxi*, but in *L. quoyi*, in one of the four specimens of *L. entrecasteauxi* examined, and apparently in *T. scincoides*, it becomes disconnected from the main vessels which then have the appearance of being carried across the cavity in 'blunt, finger-like processes' pushed out from the walls of the vesicle". It is probable that the above description of the establishment of the passage of the vessels across the allantoic vesicle holds true for *L. weekesae*.

The left umbilical vessels pass round the inner to the outer allantoic membrane. The largest vessel in the body stalk is the right umbilical vein, while the left umbilical vein is so small as to be hardly recognizable. The size and position of the vessels are shown in Text-figure 13, A. As in the earlier stages the umbilical veins pass to the liver, and the umbilical artery and vitelline artery to the dorsal aorta.

Omphaloplacentation.—In the embryos obtained from lizards opened at the beginning of the third week in January, the yolk-sac is reduced to less than half the size of the blastocyst, while in embryos obtained from lizards opened at the end of January the yolk-sac is flattened and consists of a single lining layer of enlarged endoderm cells. The yolk is restricted to these cells, and the interior of the sac contains a homogeneous coagulum which has the appearance in sectioned material of small rectangular scales. This coagulum occurs in the yolk-sac of *L. quoyi* (Weekes, 1927, Plate xxxix, fig. 3, SC. M.), and *L. entrecasteauxi* (Harrison and Weekes, 1925, Plate xlviii, fig. 5). The coagulum may be the remains of albumen. The endoderm cells lining the sac are relatively enormous, some measuring as much as 0·125 mm. in height. The cytoplasm is intensely vacuolated and is packed with small yolk spherules. Each cell has a large, irregularly shaped, deeply staining nucleus (Text-fig. 13, C).

There is very little further modification of the uterine wall beyond a slight enlargement of the columnar epithelial cells. These are largest at the edge of the placental region and smallest at the base of the yolk-sac, the cells at the sides of the yolk-sac measuring approximately 0·02 mm. in length by 0·015 mm. in

width, while the cells at the base of the sac only measure approximately 0·005 mm. by 0·002 mm. The epithelium is underlain by a network of capillaries, some of which cause bulging of the overlying epithelial cells. However, there is no definite ridge formation. The free surface of each cell is rounded and swollen and the cells are separated from each other in the apical region. The cells are densely granular, with the upper half of each cell markedly denser than the lower



Text-fig. 13.—A, section of body stalk, Stage D, × 96; B, non-ridged region of placentation in surface view, × 450; C, yolk-sac endoderm cells, × 300. *All. St.*, allantoic stalk; *L. Umb. Art.*, left umbilical artery; *L. Umb. V.*, left umbilical vein; *R. Umb. Art.*, right umbilical artery; *R. Umb. V.*, right umbilical vein; *Vit. Art.*, vitelline artery; *Vit. V.*, vitelline vein; *Y.-S. St.*, yolk-sac stalk.

and consequently staining deeper. The density is thought to be due to the concentration of secretory material at the apices of the cells. The free margins of the cells are jagged and covered by a coagulum similar in texture to, and with the same staining property as, the cytoplasmic content of the cells. This coagulum is taken to be maternal secretion, since it is also found clinging to the cells of the chorionic ectoderm, whose cytoplasm has the same densely granular appearance as the cells of the uterine epithelium. There is no trace of shell membrane at this mature stage.

The chorionic ectoderm cells are not enlarged to any extent, the maximum height being 0·01 mm., whereas in *L. entrecasteauxi*, at the late stage described, they reach the height of 0·03 mm. In the embryos fixed at the end of January, the chorionic ectoderm cells over the small area of omphaloplacentation only attain a maximum height of 0·005 mm., since this restricted region of placentation represents the basal region of the yolk-sac, and in this region neither the chorionic ectoderm cells nor the uterine epithelial cells attain any great height at any stage

examined. This peculiarity is found also in the lizards *L. quoyi*, *Tiliqua scincoides* and *Egernia whitei*. In these lizards, where the shell membrane accumulates at the base of the sac, it was thought that the presence of the shell membrane may hinder the development of the chorionic and uterine epithelial cells. But, although there is no shell membrane in *L. weekesae*, the condition of the chorionic and uterine epithelial cells at the base of the yolk-sac is the same as that in the above lizards, and hence the shell membrane cannot be the sole cause of this condition. It is suggested that the pressure of the embryo and the yolk-sac on the cells of the chorionic ectoderm and uterine epithelium may hinder their growth. The layer of chorionic ectoderm is bounded internally by a narrow layer of yolk-sac endoderm and somatic mesoderm. In the later stages it is impossible to distinguish between the endoderm and mesoderm, since the distinguishing factor—the yolk in the cytoplasm of the yolk-sac endoderm—is no longer present, as the yolk spherules have been absorbed. The extra-embryonic coelome is usually obliterated by the junction of the chorionic mesoderm and the vascular mesoderm of the yolk-sac.

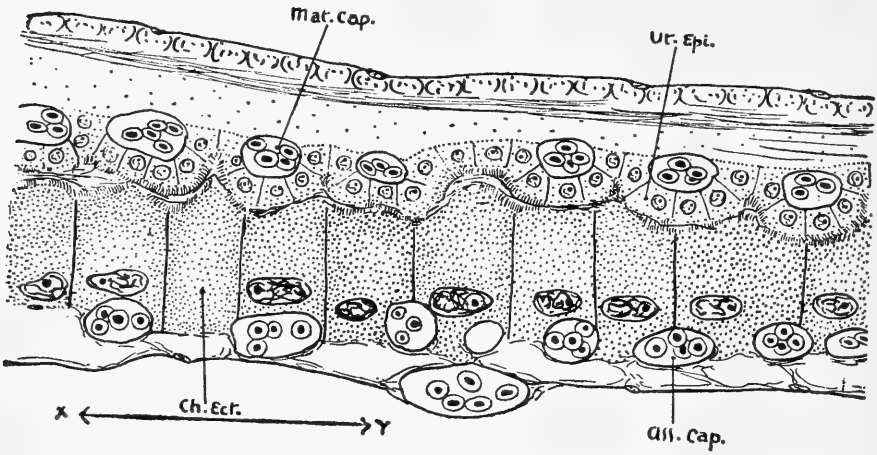
Allantoplacentation.—The general disposition of the maternal portion of the elliptical allantoplacental region has already been dealt with in the description above of the uterine circulation. There is little further development of the villous ridges after Stage C, as a comparison of Text-figures 10 and 14 will show. The chief difference is that, at the later stage, the ciliation of the ridges is more definite and the cubical epithelial cells lining the ridges are slightly enlarged, measuring approximately 0·017 mm. in height. They are granular and not vacuolated.

The foetal tissue is apposed to, but does not penetrate, the maternal tissue. However, the general form of the villous ridges impresses itself upon the underlying chorionic surface so that the cells of the chorionic ectoderm are tall where they extend into the crypts between the villi, and shorter where they are pressed against the ridges. In the embedding and sectioning of the material the maternal and foetal membranes usually separate and in some regions a few of the villous ridges are torn away from the uterine wall. This was at first thought to be due to some interpenetration of tissue, but it was found that in these regions a thick coagulum mats together the maternal and foetal cilia and so causes the tearing of the maternal tissue. This coagulum is found in the crypts between the ridges and also surrounding the chorionic ectoderm cells (Text-fig. 14).

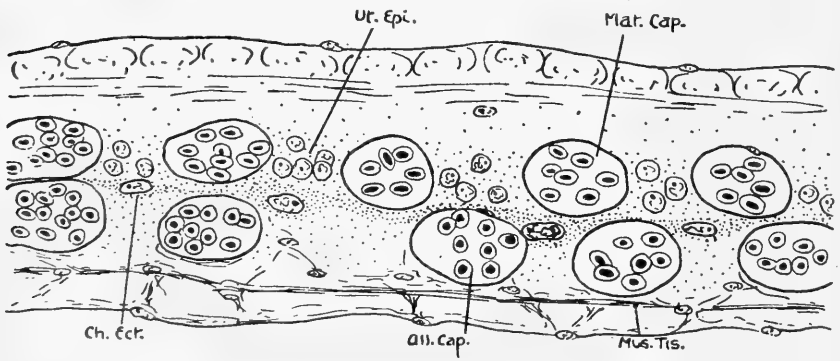
The chorionic ectoderm cells have increased in size until they are now three times as large as at Stage C. In Text-figure 14 the line XY denotes the height of the chorionic cells if the figure were drawn to the same scale as Text-figure 10. The cells attain a maximum height of 0·120 mm., but they have not increased in width. The free surface of the cells is ciliated and mammillate in form. The cell cytoplasm is granular, there are no vacuoles and the nucleus to each cell is large and vesicular, sometimes taking up the whole width of the cell and is situated normally at the cell base. Text-figure 12, A, shows a surface view of the chorionic ectoderm in this region. At the edge of this placental region there is a marked flattening of the chorionic ectoderm cells until they become the thin tapering cells characteristic of the non-ridged region. However, the cytoplasm of the flattened cells has the same appearance as that of the enlarged cells and the cell nuclei are large and always stain deeply. The allantoic capillaries in the elliptical region lie at the bases of the ectoderm cells as described for earlier

stages. There is a fairly thick sheet of mesenchymatous tissue with a distinct band of muscle fibres running through it.

This region of allantoplacentation then consists of two closely apposed, richly vascular epithelial sheets, the foetus obtaining its food by the glandular activity of the uterine epithelium and the absorbing and phagocytic powers of the chorionic ectoderm.



Text-fig. 14.—Section of elliptical allantoplacental region at maturity, × 300. *All. Cap.*, allantoic capillary; *Ch. Ect.*, chorionic ectoderm; *Mat. Cap.*, maternal capillary; *Ut. Epi.*, uterine epithelium.



Text-fig. 15.—Section of non-ridged region of placentation at Stage D, × 640. *All. Cap.*, allantoic capillary; *Ch. Ect.*, chorionic ectoderm; *Mus. Tis.*, muscle tissue; *Ut. Epi.*, uterine epithelium.

In the non-ridged region of placentation the uterine wall is thinner than in the ridged region and the surface of the uterus is smooth. The capillaries may be exposed at the surface of the uterus or they may be covered by a thin layer of epithelial cytoplasm. The epithelial nuclei between the capillaries are round and stain lightly. The foetal tissue is attached to the uterine wall by slightly enlarged chorionic ectoderm cells, but there is no interpenetration of tissue. The allantoic capillaries may be covered by a thin layer of chorionic ectoderm cyto-

plasm, or they may be exposed at the surface of the foetal tissue so that they are in immediate proximity with the overlying maternal capillaries, from which the foetus obtains its food (Text-fig. 15).

Comparison with Lygosoma (Liolepisma) entrecasteauxi and Chalcides tridactylus.

L. weekesae and *L. entrecasteauxi* are both small scincid lizards, the adult of each species measuring on an average 14 cm. They are found in the same localities, among tall grass, under the bark of trees and on logs. The times of the fertilization of the ova evidently coincide as the embryos in specimens of *L. weekesae* and *L. entrecasteauxi* collected from Jenolan on 1st December were approximately at the same stage in development. During the gestation period the females of each species carry from three to seven young and in each there is usually one more embryo in the right oviduct than in the left. The arrangement of the embryos in the incubatory chambers and the relationship between the embryo, its yolk-sac and allantois also correspond in each species.

In the late stage in the placentation of *L. entrecasteauxi* described (Harrison and Weekes, 1925) there was no trace of shell membrane, but in early stages in hand shell membrane occurs at the base of the yolk-sac, so that *L. entrecasteauxi*, like *L. weekesae*, is not strictly viviparous. However, in each species the shell membrane is so thin as to be almost negligible and does not in any way hinder the establishment of the placentae.

The omphaloplacenta and allantoplacenta of the two species are fundamentally similar. In both, the omphaloplacenta consists of a well vascularized uterine wall lined by enlarged columnar epithelial cells underlying a sheet of enlarged chorionic ectoderm cells which line the yolk-sac; the specialization of the maternal and foetal tissues is greatest at the sides of the sac. However, the cells of the uterine epithelium in *L. entrecasteauxi* are slightly larger and more uniform in size than those in *L. weekesae* and the chorionic ectoderm cells are also larger and definitely cubical, hence the omphaloplacenta in *L. entrecasteauxi* is slightly more specialized than that in *L. weekesae*.

The vascularization of the uterus, allantois, and yolk-sac is on the same plan in each lizard, although the pleat-like fold in the inner allantoic membrane described for *L. entrecasteauxi* was observed in only one specimen of *L. weekesae*.

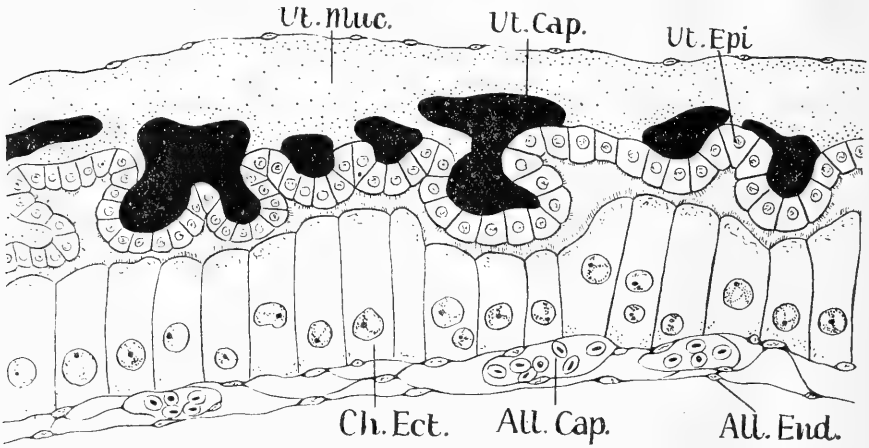
The allantoplacenta in each species consists of the two distinct regions, the elliptical area on the dorsal surface of the blastocyst and the non-ridged region between the elliptical area and the omphaloplacenta. The elliptical regions correspond in all essentials. The villi in the maternal wall are filled with capillaries, are lined by enlarged, cubical, ciliated epithelial cells and overlie and impress their shape upon greatly enlarged, ciliated chorionic ectoderm cells. These cells have the same densely granular structure and large vesicular nuclei in both lizards; the allantoic capillaries push against the cell bases in the same manner and are underlain by a thick band of mesenchymatous tissue containing muscle fibres.

However, in *L. entrecasteauxi* the villous ridges are more pronounced and run in a definite transverse direction. The ridges are deeper, since the blood vessels within them branch, and each branch forms a complementary ridge (Plate ii, figure 6). The comparative development of the two types of villous ridges is shown in Plate ii, figures 7 and 8; and Text-figures 14 and 16.

The epithelial cells lining the villi are larger in *L. entrecasteauxi* and have longer cilia. The cells of the chorionic ectoderm are also larger and have more

pronounced cilia. These differences suggest that this region of allantoplacentation in *L. weekesae* is not as highly specialized as that in *L. entrecasteauxi*.

It is impossible to distinguish between the non-ridged regions of placentation in each lizard. The structure of these regions also closely resembles that in the non-ridged region of allantoplacentation of *Denisonia superba* and *D. suta* and in the mature placenta of *L. quoyi*.



Text-fig. 16.—Section of the elliptical allantoplacental area in *L. entrecasteauxi*. *All. Cap.*, allantoic capillary; *All. End.*, allantoic endoderm; *Ch. Ect.*, chorionic ectoderm; *Ut. Cap.*, uterine capillary; *Ut. Epi.*, uterine epithelium; *Ut. Muc.*, uterine mucosa.

Chalcides tridactylus is a much larger lizard than either of the two skinks and, although it is not closely related to them, its omphaloplacenta and allantoplacenta are on the same plan. In *Chalcides* (Giacomini, 1891) an omphaloplacenta precedes the allantoplacenta, but it is not very highly developed and is marked chiefly by the persistence of thickened chorionic ectoderm. The allantoplacental area is elliptical, the villous ridges of the uterine wall running in the general direction of the long axis of the ellipse. The chorio-allantoic membrane shows ridges corresponding to the crypts in the uterine wall, but there is no interlocking between the two membranes, which are easily separable, and between which interstices filled with coagulum occur. The chorionic ectoderm of the foetal portion of the allantoplacenta, underlying the maternal ridges, is uniformly and strongly thickened, much more so than in the yolk-sac region, the cells being high and narrow, with granular contents. This epithelium is thrown into the villosities mentioned above, the bases of which are underlain by a rich vascular network.

Giacomini describes the non-ridged region as composed of closely apposed uterine and foetal tissues each with an extremely rich capillary network. From this description it seems probable that this region in *Chalcides* corresponds to that in the two skinks.

I have not access to the complete description of *Chalcides* by Giacomini, and as figures given in the paper on which I rely illustrate only the external features of the blastocyst, it is impossible for me to compare the histological structure of the elliptical region with that of *L. weekesae*. Indeed, it is not even known whether

Giacomini has published figures illustrating the histological relations in *Chalcides*, but the fact that no such figures have been produced in any general work known to me seems to imply that none exist.

However, despite these limitations, it is fairly safe to conclude that the two types of allantoplacentation closely correspond, although in *L. weekesae* the villous ridges are transverse and not longitudinal in direction; the foetal tissue is not folded to fit round the maternal villi and both the maternal and foetal faces are ciliated.

From a comparison of the placentation in the three lizards, *L. weekesae*, *L. entrecasteauxi*, and *Chalcides tridactylus*, it seems justifiable to conclude that the placentation in *L. weekesae* is not as highly specialized as that in *L. entrecasteauxi*, which in its turn is not as highly specialized as that in *Chalcides tridactylus*.

Theoretical Considerations and Summary.

It is interesting that two species, *L. weekesae* and *L. entrecasteauxi*, of the same subgenus should have allantoplacentae which, although fundamentally similar, have differences in structure which immediately suggest that one is not as highly specialized as the other. However, to theorize on the relationship of the placentae of the two species at this stage is impossible, since *L. entrecasteauxi* and *L. weekesae* are the only two members of the subgenus *Liolepisma* for which placentation has been described. But one cannot fail to see the significance and possible importance of an investigation into reptilian placentation.

The following is a summary of the chief facts observed:

1. Omphaloplacentation and allantoplacentation are here described for the scincid lizard *Lygosoma* (*Liolepisma*) *weekesae*.

2. A remnant of shell membrane occurs at the base of the yolk-sac so that the lizard is not strictly viviparous.

3. The embryos for which placentation is described range from approximately two to ten weeks in age.

4. The umbilical vessels pass from the inner to the outer allantoic membrane across the cavity of the allantoic vesicle, as described in the paper on *Lygosoma quoyi* (Weekes, 1927*a*).

5. The omphaloplacenta is not as highly specialized as that in *Lygosoma* (*Liolepisma*) *entrecasteauxi* (Harrison and Weekes, 1925) and consists of a well vascularized uterine wall with columnar epithelium underlying a sheet of enlarged chorionic ectoderm cells which covers a well vascularized yolk-sac.

6. The extra-embryonic mesoderm grows round the yolk-sac embedded in its substance as described for *Lygosoma quoyi* (Weekes, 1927*a*).

7. The allantoplacenta consists of a ridged and a non-ridged region. The ridged region is elliptical and extends from one end of the dorsal surface of the blastocyst to the other. The maternal portion is composed of vascular villous ridges lined by cubical epithelium, which overlie, but are in no way attached to, a sheet of greatly enlarged chorionic ectoderm cells.

8. The non-ridged region comprises the remaining part of the uterus embraced by the allantois. Here the maternal and foetal tissues are partially degenerated and the maternal and foetal bloodstreams are in close proximity.

9. The placentation is compared with that in *Lygosoma* (*Liolepisma*) *entrecasteauxi* and *Chalcides tridactylus* and is considered to be less specialized.

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EXPLANATION OF PLATES I-II.

Lettering.

All. Cap., allantoic capillaries; *Ch. Ect.*, chorionic ectoderm; *Ch-Omp-All. M.*, chorio-omphalo-allantoic membrane; *Coag.*, coagulum; *D. St. Ut. Epi.*, deeply staining uterine epithelium; *Foet. T.*, foetal tissue; *Foet. V. R.*, foetal vascular ridges; *I. All. M.*, inner allantoic membrane; *Mat. Cap.*, maternal capillary; *Mat. V. R.*, maternal villous ridge; *O. All. M.*, outer allantoic membrane; *Sh. M.*, shell membrane; *Ut. Epi.*, uterine epithelium; *Ut. Gl.*, uterine gland; *Y-S.*, yolk-sac; *Y-S End.*, yolk-sac endoderm.

Plate i.

Fig. 1.—Photomicrograph of section of allantoplacenta of *D. superba* in the yolk-sac region, showing the chorio-omphalo-allantoic membrane, the enlarged chorionic ectoderm cells and the exposed capillaries at the surface of the uterine wall. × 235.

Fig. 2.—Photomicrograph of section of allantoplacenta of *D. superba* in the embryonic region, showing the vascular ridges in the maternal wall with the foetal tissue attached. × 74.

Fig. 3.—Photomicrograph of section of three of the vascular ridges in the allantoplacenta of *D. superba*. × 235.

Plate ii.

Fig. 4.—Photomicrograph of section of yolk-sac of the late stage in the development of *D. superba*, showing in particular the apposition of the inner and outer allantoic membranes and the well defined chorio-omphalo-allantoic membrane. × 53.

Fig. 5.—Photomicrograph of section through the allantoplacenta of *D. suta* showing the maternal and foetal ridges. The shrinkage of the tissues due to indifferent fixation is evident. × 168.

Fig. 6.—Photomicrograph of section of uterine wall in ridged region of allantoplacentation in *Lygosoma* (*Liolepisma*) *entrecasteauxi* (Harrison and Weekes, 1925).

Fig. 7.—Photomicrograph of total preparation of elliptical placental area in uterine wall showing villous ridges and uterine blood-vessels.

Fig. 8.—Photomicrograph of total preparation of elliptical placental area in uterine wall of *L. entrecasteauxi* (Harrison and Weekes, 1925).

ON THE TYPE LOCALITY OF CERTAIN FLIES DESCRIBED BY MACQUART IN "DIPTÈRES EXOTIQUES," SUPPLEMENT FOUR.

By G. H. Hardy.

[Read 24th April, 1929.]

About one hundred and forty species of Australian flies are described by Macquart in the fourth supplement of his Diptères Exotiques, the type locality being given there as Tasmania. The collecting of this material is credited to the Verreaux Brothers as is definitely stated in two places:

"De la Tasmanie, ou terre de Diemen, il a été envoyé au Muséum d'histoire naturelle de Paris, par les frères Verreaux, voyageurs de cet établissement, une collection considérable d'insectes, parmi lesquels les Diptères présentent un assez grand nombre d'espèces nouvelles qui nous ont été également communiquées." (Macquart, *Mém. Soc. Roy. Agric. et Arts, Lille*, 1846 (1844); *Dipt. Exot.*, suppl. 1, 1846, p. 6).

"Enfin, MM. Verreaux, voyageurs du Jardin du Roi, en envoyèrent un grand nombre de la Tasmanie.

"Les lieux où ont été recueillis particulièrement les Diptères que nous avons décrits sont: dans la Nouvelle Hollande, le port du Roi Georges, l'île des Kanguroos, la baie de Jervis, l'île King, la ville de Sydney et le Port Jackson; dans la Tasmanie, Hobart-Town." (Macquart, *Dipt. Exot.*, suppl. 2, 1847, p. 6.)

From this second statement, it would appear that the Verreaux Brothers covered the south coast of Australia, up the east coast as far as Sydney, and that they were in Hobart, Tasmania. There is no definite evidence as to how these collectors treated their material, but, as is to be detailed below, it is very evident that their localities became confused.

I have brought together all the information I can secure concerning these Verreaux Brothers, and most of this is gleaned from papers by the late J. H. Maiden, this author apparently being unaware that there were two brothers operating under that name.

There is a book, "L'Oceanie en Estampes," 1832, by Jules and Edouard Verreaux, a copy of which is in the Mitchell Library. As far as I can gather from the few minutes I was able to examine the publication, it is a translation into French of subjects taken from Cook's voyages.

In "Colonial Wools" (Southey, 1851, p. 199—I have not seen this work—*see* Maiden, *Journ. Roy. Soc. N. S. Wales*, lv, 1921, 168), it would appear that Jules Verreaux had at that date (1851) but recently returned to Paris with his large collections. Nevertheless, judging from the date of Macquart's fourth supplement, several years must have elapsed between the event Southey referred to and the date of his publication, for Macquart published on the material in 1849 and the three previous years.

Maiden discovered yet another record: J. P. Verreaux was elected a member of the Tasmanian Society on the 2nd January, 1843 (reported in the *Tasmanian Journal*, ii, 1843, 158, 160; *see* Maiden, *Journ. Roy. Soc. N. S. Wales*, xliv, 1910, 153). At the latest the Verreaux Brothers must have arrived in that island in 1842. As they are said to have been away from France for five years, this suggests 1842 to 1846 as the probable period of their sojourn in Australia and Tasmania. These dates do not quite coincide with Macquart's dates of publication, the earliest being apparently 1846, the year P. Verreaux had presumably returned to Paris, and seven years before Southey reported the fact.

When redescribing Macquart's *Ochromyia hyalipennis*, Surcouf records "7 femelles originaires de Tasmanie, recueillies par Verreaux en 1846" (*Nouv. Arch. Mus. Paris*, vi, 1914, 85). This would suggest that the Verreaux Brothers were in Australia in 1846, unless this date is not the year of capture, but the year in which the insects were received in Paris and there labelled.

Desmurs (1842) gave an account of J. Verreaux, referring to his appointment as collector to the Natural History Museum, Paris, and stated that he was proceeding to Australia. The date of publication is November, 1842, but the note may have been written long before then.

It would seem that the Verreaux Brothers were in Australia shortly before the abolition of the transportation of convicts, and when various explorations were in progress. The population was more than a quarter of a million. Few opportunities would be available of getting far afield; the nearest centres to Sydney from which they could have worked were limited, the towns then founded being Bathurst (1815), Illawarra (1826), and Newcastle (1831). There is no evidence that they reached these centres, whilst Hobart is apparently the only place from which they worked in Tasmania. Nor would there have been any inducement to go far afield from either Sydney or Hobart, as little collecting had been done in these districts, both of which abounded in material of considerable interest. Localities like "le port du Roi Georges" (Albany), "l'île des Kanguroos," "l'île King" and "le baie Jervis," might have been touched in passing along the coast and no stop of long duration made.

The third point of interest is bound up in the identification of Macquart's material and its range as now known. Of the families so far studied in detail, the results of Ferguson's examination of the Tabanidae seem to be the most complete, as types have been examined where practical. Macquart described ten Tabanids from Tasmania in his fourth supplement, and White (1915) did not recognize any of them from that locality. Five names are placed under *Pangonia*, Ferguson and Hill (1922) recognizing them as follows:

1. *P. rufovittatus* = *Corizoneura chrysopila* Walker, from New South Wales.
2. *P. dorsomaculata* = *Osca*. Not known to Ferguson (1924).
3. *P. violacea* = *Diatomineura violacea*, from New South Wales to Queensland.
4. *P. subappendiculata* = *Diatomineura inflata* Ricardo, from New South Wales.
5. *P. anthracina* = ? *Apocampta subcana* Walker, from New South Wales and Queensland.

Of the four species described as from Tasmania under the genus *Tabanus*, *fraternus* was unknown to Ferguson, *cyaneus* is known from New South Wales

and Queensland, as recorded in the Ferguson manuscripts, and two species, *similis* and *cyano-viridis* remain unmentioned. *Chrysops testaceus* also remains unrecognized.

Apropos of this matter, Ferguson made two statements: "The locality (Tasmania) given by Macquart is probably wrong, other records appear to be all from Sydney" (Ferguson and Hill, Proc. Linn. Soc. N.S.W., xlvii, 1922, 248).—"The habitat (Tasmania) given by Macquart is to be doubted, as in the case of other species described from Tasmania, it is now known that they do not occur in that island but are found in the coastal districts of New South Wales and Queensland" (Ferguson, *Bull. Ent. Res.*, xiv, 1924, 261).

I do not think these remarks made by Ferguson are intended to cover more than the Tabanidae, although there must have been a very strong suspicion in Ferguson's mind that the error in location might be more widely applied; indeed the following bears this out when he dealt with the Syrphidae: "Tasmania: This locality even must be viewed with doubt, as many specimens described from Tasmania in this portion of Macquart's work are now known to be from the mainland" (Ferguson, Proc. Linn. Soc. N.S.W., li, 1926, 181).

In his papers on the Syrphidae, Ferguson deals with seven of the twelve species described as from Tasmania; three of these are mainland forms unknown from that island, and three extend in range from Tasmania to New South Wales, the other one being unrecognized. References to Syrphidae in Ferguson's manuscripts give *Psilota* (*Chrysogaster*) *cuprea* as being from New South Wales and Western Australia, whilst *P.* (*Coeloprosopa*) *nitida* is considered definitely Tasmanian, and unknown from the mainland.

Dr. C. P. Alexander (1922, p. 587) attributes the name *Tipula nigrithorax* Macquart to a New South Wales species of *Leptotarsis*, although it was originally described from Tasmania. He gives no explanation for so doing, nor does he query the Tasmanian record, presumably taking this to be within the probable range of the species.

Dr. W. S. Patton (1925), who examined the type, identifies *Ochromyia hyalipennis* Macquart (name preoccupied) with the common Sydney blowfly *Calliphora ochracea* Schiner. This conclusion I have since challenged (Hardy, 1926, p. 170) because the Sydney species was quite unknown from Tasmania where the allied *C. nigrithorax* Malloch takes its place. Malloch erroneously placed this species as a form of *ochracea*, which it cannot be, as the male has the face almost as wide as that of the female, whereas on the male of *ochracea* the eyes are contiguous. I now give credence to Patton's findings, despite the fact that Macquart's description fits the Tasmanian form better than that from Sydney.

In my own studies I am forced to come more and more to the conclusion that Tasmania, as a locality, cannot be accepted wherever found in the fourth supplement. In the Asilidae this belief fits remarkably well and it is a basis upon which I am covering the whole of my researches anew. There are quite a number of alterations to be made in this respect. In no way does this affect Tasmania as a locality in other parts of the *Diptères Exotiques*, but it does raise the question as to whether further mistakes have been made in location.

Summary and Conclusions.—I have brought together various factors that have led me to the conclusion that although Macquart published the descriptions of about one hundred and forty species of Diptera in his fourth supplement as being from Tasmania, the majority, if not all, were from Sydney. In so doing I have selected evidence from Ferguson, Alexander and Patton, three authors whose

reputations in their respective branches stand high. Doubtless there are other cases to be found in literature. In my own case, I have hitherto followed the conservative policy of accepting Macquart's locality as being correct unless it can be shown otherwise, but from now onward I will revise this procedure in conformity with the views expressed above. The possibility of this mistake having been made in type locality has been looming larger and larger as the years have gone by, but I do not think there are many entomologists who had conceived the mistake to be as far reaching as I have here expressed it. Nevertheless I think if my view becomes generally accepted, it will lead to quite a number of outstanding species being recognized and synonymy more certainly ascertained. This contribution is therefore offered by me, not with a view to its general acceptance in every detail, but rather as a basis for critical study. The matter is one of importance that I believe to be worthy of wide discussion.

I have to acknowledge my indebtedness to Mr. A. Musgrave of the Australian Museum, Sydney, who has been of considerable aid to me when drawing up this paper, checking references, quotations, etc., and in supplying most of the references, some copied, concerning the Verreaux Brothers. Besides those recorded above, he drew my attention to yet another reference in the *History of the Collections contained in the Natural History Department of the British Museum*, ii, Birds, p. 503, under Verreaux, Maison, referring to yet another brother, Alexis, who died in South Africa.

Also I am indebted to Dr. I. M. Mackerras who has supplied the information from the Ferguson manuscripts as well as aided with criticisms.

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AUSTRALIAN COLEOPTERA: NOTES AND NEW SPECIES. VI.

By H. J. Carter, B.A., F.E.S.

(Five Text-figures.)

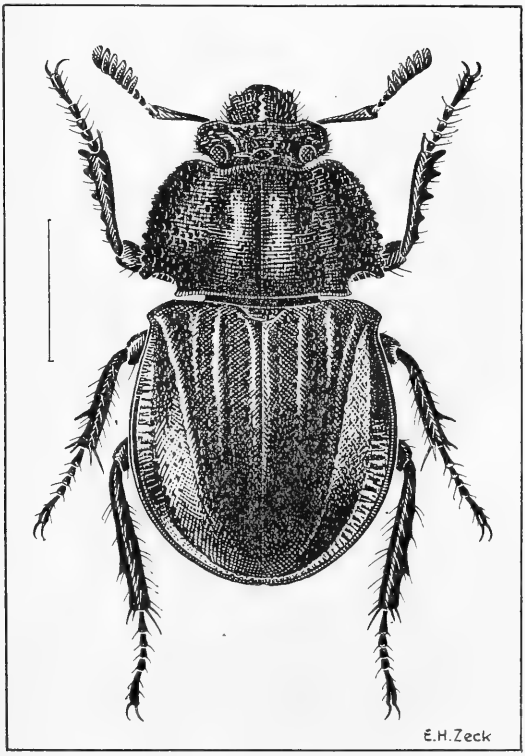
[Read 24th April, 1929.]

Lucanidae.

Rhyssonotus costatus, n. sp. Text-fig. 1.

Oval, dark brownish-bronze, nitid, glabrous except for setae (long and numerous on mandibles, short and sparse on head and femora, alternating with lateral crenulations on pronotum).

Head (2·5 × 5 mm., excluding mandibles), coarsely rugose-punctate, front with saddle-shaped ridge terminating anteriorly in a large tubercle, sides widely lobate,



Text-fig. 1.—*Rhyssonotus costatus*, n. sp.

the lobes obliquely narrowed to front, more squarely rounded off behind, tubercle in front of eye; mandibles projecting about 2·5 mm., each armed internally with four, externally with two blunt teeth, their upper surface tuberculose and coarsely punctate, with long setae; eyes divided, bordered internally by a strong carina; antennae with scape shorter than rest combined; club 6-segmented. *Prothorax* 5 × 9 mm., anterior angles widely rounded off, sides lightly and arcuately widened to an acute subposterior tooth preceding a large oval excision, posterior angle acutely dentate; lateral border dentate-crenulate; surface coarsely rugose-punctate, save on raised ridges on each side of wide medial groove; four longitudinal depressions, two near apex, two near base external to medial ridges. *Scutellum* transversely oval, punctate. *Elytra* slightly longer than wide (10 mm. long), sides explanate, extreme border raised and entire, a row of large punctures on inside of explanation, humeri dentate; edges of suture carinate, a strongly raised subcrenulate costa extending obliquely from shoulder to middle of apical declivity, and two short straight costae extending from base at equal intervals between first costa and suture; the first costa coarsely rugose on sides; irregularly seriate-punctate, the two rows of small punctures near suture more regular than rest. Underside sparsely punctate; flanks of prosternum with large sparse setae, mesosternum with large foveate depression.

Dim.—19 × 10 mm., including mandibles.

Hab.—New South Wales: E. Dorrigo (W. Heron).

A single male example shows a very distinct species remarkable for its costate and coarsely sculptured surface, with strongly crenulate margins to the prothorax. The general form and structure of head is nearest that of *R. politus* Cart., but the posterior excision of prothorax is deeper and more rounded than in that species.

Holotype in Coll. Carter.

Buprestidae.

STIGMODERA (THEMOGNATHA) MARGINALIS, n. sp. Text-fig. 2.

Oblong-ovate. Head, pronotum and underside black, the pronotum very nitid and glabrous, with an orange margin not extending to base; elytra dark brown, becoming reddish-brown towards apex, with an orange margin throughout extending over the lateral three intervals except near base—here only on external sulcus; legs blue.

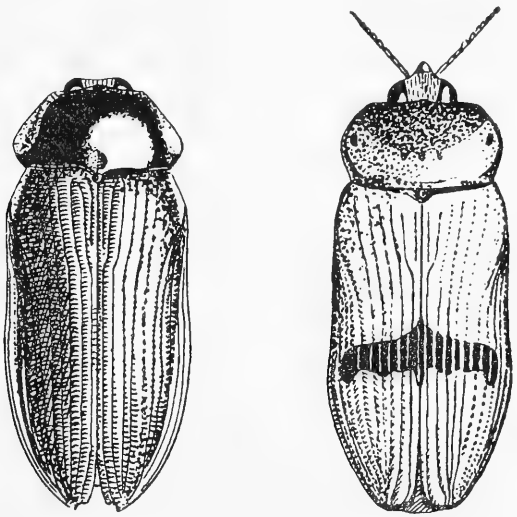
Head with close round punctures, glabrous and very lightly sulcate and excavate. *Prothorax* (6 × 11 mm.): Apex and base bisinuate, widest and strongly protuberant at basal third, thence obliquely narrowed to front, arcuately and less strongly behind; anterior angles acute, posterior widely obtuse; disc finely punctate, the punctures dense towards apex and sides, subobsolete at base and very feebly rugose on margins; a short smooth medial line shown on posterior half terminated by shallow fovea. *Scutellum* linguiform, nitid and impunctate. *Elytra* 21 × 12 mm., of same width as prothorax at base, very lightly widened at shoulders and lightly sinuate behind them, apices dehiscent and separately rounded save for a very small rounded excision at extremity; striate, intervals more or less uniformly convex; very sparsely and lightly punctate. Underside wholly black, glabrous, closely and somewhat rugosely punctate.

Dim.—29 × 12 mm.

Hab.—Western Australia (H. W. Brown).

A single ♀ sent by that most enterprising of coleopterists, Mr. H. W. Brown, shows a species that in colour is nearest to *S. flavocincta* L. & G., but in the form and surface of prothorax belongs to the *oleata-caroli* group, with an even more marked lateral extension, not quite deserving the term angulate. The apical emargination is also characteristic and unusual—somewhat as in the ♂ of *S. sanguinosa* Hope, as shown in my Revision (*Trans. Roy. Soc. S. Aust.*, 1916, p. 84).

Holotype in Coll. Carter.



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Text-fig. 2.—*Stigmodera* (*Themognatha*) *marginalis*, n. sp.
Text-fig. 3.—*Stigmodera* (*Themognatha*) *particollis*, n. sp.

STIGMODERA (THEMOGNATHA) PARTICOLLIS, n. sp. Text-fig. 3.

Oblong-ovate. Head, two-thirds of pronotum, underside (chiefly) and appendages bright metallic greenish-bronze, the pronotum with a wide sublateral area yellow (non-metallic) extending over about one-third of surface, leaving a narrow lateral and basal margins bronze; abdomen with apical segment and a few spots on other segments flavous; elytra testaceous, except for a narrow basal margin, still narrower apical margin and a narrow postmedial fascia black, the fascia not extending to sides and bracket-shaped, with short longitudinal extensions backward on eighth stria.

Head glabrous, moderately sulcate and excavate; strongly and closely punctate. *Prothorax*, 6 × 11 mm., lightly bisinuate at apex and base, sides widely rounded, widest at basal third, all angles obtuse, the posterior widely so; disc rather finely and closely punctate, a little rugose at sides; punctures larger and more remote on basal half; a short, smooth medial line indicated towards base; without basal fovea. *Scutellum* linguiform, nitid golden-bronze. *Elytra* as wide as prothorax at base, widened at shoulders, lightly sinuate before the middle, widely rounded at apex; each widely subangulate at suture; striate, becoming striate-punctate

towards apex and sides, the striae here with rather large close punctures, intervals lightly convex for the greater part, nearly flat at base, and impunctate. Underside nitid and glabrous, strongly punctate, the punctures of prosternum close and round, of abdomen more irregular and rugose, the apical segment almost wholly flavous, two small yellow marks on each side of the two preceding segments and one on the second segment.

Dim.—29 × 12·5 mm.

Hab.—Western Australia (H. W. Brown).

A single ♀ sent is another of Mr. H. W. Brown's discoveries. It is nearest in pattern to *S. pictipes* Saund., but, besides the different arrangement of the metallic and yellow areas of the pronotum, the form is more like that of the preceding species (e.g., strongly widened at basal third—though more rounded than in *marginalis*), sides not at all sinuate in front (as in *pictipes*), the elytral fascia placed farther forward and of black colour, besides different in shape from that of *pictipes*. The extreme apex is very narrowly darkened, though this may be a variable feature.

Holotype in Coll. Carter.

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Text-fig. 4.—*Stigmodera* (*Castiarina*) *duaringae*, n. sp.
Text-fig. 5.—*Stigmodera* (*Castiarina*) *sexualis*, n. sp.

STIGMODERA (CASTIARINA) DUARINGAE, n. sp. Text-fig. 4.

Oval, convex. Head, pronotum and underside coppery-bronze, nitid and glabrous, antennae and upper surface of legs greenish-bronze, elytra blue-black with testaceous markings as follows: a wide basal fascia interrupted at the suture and extending shortly backwards at sides, two transversely oval medial spots, two smaller transverse lateral spots near lower margins of the preceding, a narrow undulate pre-apical fascia, narrowly interrupted at the suture, extending to and widened at sides.

Head deeply excavate, the excavation bordered by carina on its front half and rugose-punctate. *Prothorax*: Apex arcuately produced at the acute angles, base very slightly bisinuate, posterior angles subacute; sides arcuately narrowed from base to apex; disc irregularly and rather coarsely punctate, rugulose at sides; a large, elongate basal fovea and a medial channel shown on apical half.

Scutellum blue, subcordate, depressed. *Elytra* as wide as prothorax at junction, thence rather suddenly widened at shoulders, then successively compressed, roundly widened and sharply attenuate to apex. Apices strongly bispinose with long exterior spine, margins strongly serrulate on apical third; punctate-striate, seriate punctures unusually coarse, intervals convex throughout and very sparsely punctate. Underside almost glabrous, nitid and finely punctate.

Dim.—11 × 5 (vix).

Hab.—Queensland: Duaringa (Mr. W. B. Barnard).

A unique male example was sent me in May, 1924, by its captor, one of the well-known family of Queensland naturalists, but I hoped to get further material. It is, however, so clearly distinct from others of the *assimilis* Hope-*inconspicua* Saund. group that it deserves a name, the distinctions being the combination of oval form, sharply bispinose apices, serrulate hind margins and a unique pattern.

Holotype in Coll. Carter.

STIGMODERA (CASTIARINA) SEXUALIS, n. sp. Text-fig. 5.

Oblong, lightly attenuate behind, moderately convex. Head and pronotum bronze, the latter bluish at sides; elytra testaceous with blue or greenish-blue markings as follows: narrow basal margin, a post-basal fascia narrow, with anterior margin concave, posterior straight, extended to base at the scutellum but not extending to sides; a post medial fascia, wider than former, undulate, widened at suture and narrowly extended both ways to the other fascia and apical spot. The last subtrapezoidal, the sides more or less parallel to margins, leaving a wide testaceous or orange border, the shortest side resting on, and generally slightly widened at the apex. Underside blue, abdomen in the male red, in the female blue, rather densely covered with flattened silvery hair, antennae and legs bluish.

Head excavated, closely punctate. *Prothorax* rather strongly convex, apex truncate, base lightly bisinuate, sides nearly straight on posterior two-thirds, or slightly widened in front of middle, arcuately narrowed anteriorly, the front angles wide, posterior rectangular: disc closely and rather uniformly punctate, a little rugulose at the flattened latero-basal margins, medial channel clearly marked on basal half, sometimes continuous to apex, terminated behind in a large fovea. *Scutellum* subcordate, depressed and punctate. *Elytra* as wide as prothorax at base, lightly enlarged at shoulders, scarcely compressed at middle, apices rather widely truncate, posterior margins entire; punctate-striate, seriate punctures large, intervals flat and rather coarsely punctate, especially on dark areas.

Dim.—11 × 4 mm.

Hab.—Queensland: Stanthorpe (Mr. E. Sutton).

I am indebted to this keen naturalist for some sixteen examples (11 ♂, 5 ♀) that show the sexual coloration recorded in my Revision of the genus (*Trans. Roy. Soc. S. Aust.*, 1916, p. 83) for *S. jekelli*, *cruenta* and other species. It is also the species erroneously determined as *S. cara* Blkb. (= ? *placens* Kerr.) in these PROCEEDINGS (1928, p. 272) by me, from which it differs in its darker pronotum, different apical structure and in having entire subapical margins. It differs from *S. affabilis* Kerr. (= *simplex* Kerr.) by its narrower and less convex form, its truncate apices and much more extensive yellow area of elytra, as also in the sexual coloration of the abdomen.

Holotype and allotype in Coll. Carter.

N.B.—S. sexualis has been compared with the unique type of *S. placens* Kerr. by Mr. Blair, but *S. cara* Blkb. is not in the British Museum, though its type was said to be there in Mr. Lea's record of the Blackburn types (*Trans Roy. Soc. S. Aust.*, 1912, p. xxxviii). The synonymy of *cara* and *placens* was stated by Blackburn, and acknowledged by Kerremans (*Ins. Gen.*).

Cyria australis Boisd.—From an examination of long series of *C. tridens* Blkb. and of *C. imperialis* Don., including the black varieties of both, I agree with Mr. Blair, who writes of *australis*: "I find our series is mixed, most of them being black forms of *tridens*, while a few are a similar black form of *imperialis*. From Boisduval's remark that 'the thorax is a little different from that of *imperialis*', one must, I think, assume that his species is of the *tridens* form, and *gagates* Hope, of which I have seen the type, is the same. It would appear, therefore that the black form of *imperialis*, which is much rarer, is nameless".

I propose the name *melaina* for this variety. The following synonymy holds:

C. imperialis Don. var. *melaina* Cart.

C. australis Bois. = *gagates* Hope, var. *tridens* Blkb.

The black form *australis* is apparently commoner in Southern Queensland, but there is great variety of coloration in the species. Examples from Coff's Harbour, N.S.W., vary from the pattern described by Blackburn, to those having the elytra with a yellow margin and two or three pairs of small, yellow spots. All black examples also occur; the pronotum may be with or without the yellow margin.

Iridotaenia bellicosa Blkb. (*Paracupta*) = *I. terrae-reginae* Obenb. (*Arch. f. Naturg.*, 1924, p. 36).

Mons. Théry having recently written me as to the need for referring Blackburn's species to *Iridotaenia* rather than to *Paracupta*, I find that Dr. Obenberger is clearly of the same mind, since his description of *terrae-reginae* exactly fits this well-known Queensland species. I have specimens from Kuranda.

Pseudanilara Théry = *Neotorresita* Obenb.

My conviction as to the identity of the above genera is not at all disturbed by the meticulous comparison of alleged differences contained on pp. 58, 59 (*Archiv. f. Naturg.*, 1928). This comparison is a little disingenuous in that Dr. Obenberger does not use the words of his original description to compare with selections from the original description of Théry. Thus, in one detail, he contradicts his own description by his new diagnosis, as follows:—

Pseudanilara Théry.	*Neotorresita* Obenb.	
Original description.	Original description.	As given in *Archiv. f. Naturg.*, 1928.
Hanches postérieures 'robustes, sinueuses'	Hanches postérieures 'assez larges et longues'	Hinterhüften "ziemlich schmal, uber parallel-seitig, vorne geradlinig, gegen die Seiten nur sehr schwach vereugt."

The other compared differences are comparatively unimportant; as for example, the third art. of antennae: "subdenté", Théry; "Kaum triangelförmig", Obenb. Such details often depend on the point of view and position of the segment. Again, as to the visibility of the antennal cavities, Théry says, "seulement par dessous"; Obenberger says, in the original description, "petites, subterminales, ouvertes"; in his polemical note "aber von vorne deutlich sichtbar". A re-examination of *P. cupripes* Macl. shows that it is best seen from a position between these, i.e., obliquely in front and below. Such hair-splitting is scarcely scientific. The excellent figure that accompanied Obenberger's original description, together with that description, was sufficiently convincing to me of the synonymy of *Neotorresita achardi* with *P. cupripes* Macl.—a comparatively common and widely distributed insect.

The table of the alleged species on p. 59 is erroneous. Macleay's species, for example, are closely allied as species. It is absurd to separate them generically. Such an arrangement could only be made after an exhaustive and minute examination of the types. This has not been possible to Dr. Obenberger in the case of Macleay's three species, my own four species, Blackburn's *Neocuris dilaticollis*, and doubtfully of Kerremans' two species, the types of which I examined in the British Museum, together with that of Blackburn. I had then with me specimens that I had previously compared with Macleay's types in Sydney. I again assert that all the above are congeneric, with the "Hekatombe von Synonymen" that I believe to be accurate though "radikal". These types, together with my specimens, were shown by me to Mr. K. G. Blair, who agreed with me then as to their close similarity, and who has since then written me as to the similar generic position of *Neocuris nigricans* Blkb., which I suspected from its description, when I was revising the genus *Neocuris*.

Stigmodera.—Dr. Obenberger's answer to my criticisms contained in these Proceedings, 1924, p. 533, amounts to a categorical denial of each of the fifteen species, and four out of the five varieties and subspecies being synonymous with certain recorded species. In view of the difficulties that must arise when future students desire an accurate nomenclature, it seems idle further to publish contradictory opinions on questions which are largely matters of fact, or, in some cases, a matter of interpretation of variation. This latter can only be judicious at the hands, or under the eyes, of trained naturalists who have actually seen a considerable number of individuals, preferably as field observers. As this is a difficult matter to arrange, I would suggest as a compromise: (1) that Dr. Obenberger send his types, or specimens that have been compared with his types and certified by him to be conspecific therewith to the British Museum, where a larger number of recorded types are contained than in any other existing institution, for the opinion of the Entomologists of that Museum; (2) that the opinion of such Entomologist (or Entomologists) be published on each of the species in question between Dr. Obenberger and myself. On my part I will gladly forward to that Museum all such material as may be necessary as regards my own species or determinations.

Failing such an arbitration, future authors must themselves judge between us, due consideration being given to the great variations, especially of colour and size, a few of which were stated in my Revision of the genus (*Trans. Roy. Soc. S. Aust.*, 1916, pp. 80-85).

Meanwhile Dr. Obenberger publishes the description of sixteen more alleged new species of *Stigmodera*, of which fourteen are figured. Of these I cannot

see anything in the descriptions or figures that would deny the following synonymy:—

1. *S.* (*Themognatha*) *mrazi* Obenb. = *donovani* L. and G.
2. *S.* (*Themognatha*) *jakovlevi* Obenb. = *sanguineocincta* Saund.
3. *S.* (*Castiarina*) *tasmani* Obenb. = *jubata* Blkb., var.
4. *S.* (*Castiarina*) *semenovi* Obenb. = *moribunda* Saund., var. *dispar* Blkb.
5. *S.* (*Castiarina*) *odewahni* Obenb. = *hopei* Saund.
6. *S.* (*Castiarina*) *cicerini* Obenb. = *erythromelas* Boisd.
7. *S.* (*Castiarina*) *gebhardti* Obenb. = *sagittaria* L. and G.
8. *S.* (*Castiarina*) *acutangula* Obenb. = small *cupreoflava* Saund., var. *equina* Blkb.
9. *S.* (*Castiarina*) *stigmaticollis* Obenb. = *octospilota* L. and G., var. *rufipes* Macl.
10. *S.* (*Castiarina*) *yorkensis* Obenb.—The pattern and form is a common one, but the description is not clear as to colour. The one word "schwarz" in the first line would appear to apply to every part, where its colour is omitted, e.g., underside and elytral pattern. Again there is no comparison, as with so many of this author's descriptions, with its allies, a very important omission.
11. *Neotorresita microphaenops* Obenb. = *Pseudanilara purpureicollis* Macl., var. *nigra* Macl.

Notes on the Above.

1. I incorrectly placed *jansoni* Saund. as synonymous with *donovani* L. and G. in my Revision. This was corrected later (Proc. Linn. Soc. N.S.W., 1922, p. 68).

2. The sides of the elytra in this species vary in colour, the red often shading off into pale yellow. The pronotum is exceptionally strongly sculptured, a fact curiously unnoticed by Saunders.

3. Tasmanian species are so few that I cannot believe that this and 6 can be otherwise than variations of the well-known species mentioned above. *Vide* These Proceedings, 1919, pp. 137-139, for notes on Tasmanian species; also These Proceedings, 1924, p. 521.

4 and 9 exactly correspond with specimens lately examined, the type of *rufipes* Macl. containing, as in its description, every mark figured by Obenberger.

5, 7 and 8 are all well-known and variable species; 5 and 7 with a wide distribution in Western Australia.

N.B.—*placida* Kerr. is not synonymous with *hopei* Saund., as in my Revision.

Chrysobothris Esch.—In a footnote, p. 287, Dr. Obenberger corrects the spelling of this genus to *Chrysobotris*. I have not been able to see the original paper (*Zool. Atl.*, 1, 1829), but in Scudder's "Nomenclator Zoologicus", p. 67, and in the well-known work by Agassiz (Col., p. 36) the word is spelt *Chrysobothris* and the Greek derivation is given. Even if the original paper misprinted this *Chrysobotris*, the long-established usage seems to entitle the claim of the more scholarly form derived from *βοθρίον* (foveola).

Dascillidae.

Dascillus serraticornis, n. sp.

Ovate, nitid, dark brown; a short oblique vitta near shoulder of elytra, also tarsi, red; upper surface moderately clad with upright silvery hair (generally abraded near middle regions).

Head: Eyes round, very prominent, finely faceted; antennae long, extending beyond base of prothorax, segment 1 swollen, 2 nodulose, 3-11 triangular, each forming a sharp rectangular serration on interior margin and successively narrower. *Prothorax*: Apex of same width as head, sides soon strongly widened, widest near (not at) base; base strongly sinuate, with short truncation at scutellum, anterior margins decurved, posterior angles feebly falcate; anterior part of disc convex; slightly depressed towards base; densely and finely punctate and pilose. *Scutellum* rather large, subpentagonal. *Elytra* feebly obovate, narrowly margined; striate-punctate, strial punctures close; intervals just perceptibly convex and rather closely punctate, the interstitial punctures smaller than the seriate; the reddish shoulder stripe extending about one-third of elytra. Prosternal process sharply triangular between rather approximate coxae, underside seriate-punctate and subnitid, tibiae straight, tarsi slender.

Dim.—7-9 × 3-4 mm.

Hab.—Queensland National Park, MacPherson Range (H. J. Carter).

I took eight examples by beating in January, 1928. The species is readily distinguished from *D. brevicornis* Macl. (type examined) by its strongly serrate antennae, besides colour differences.

Holotype in Coll. Carter.

Tenebrionidae.

PLATYDEMA HERONI, n. sp.

Ovate-convex, nitid black, elytra with two shoulder spots and two latero-apical spots red; appendages black, or nearly so, tarsi piceous.

Head unarmed, coarsely punctate, epistoma semicircular, antennae not quite reaching base of prothorax; segments 5-10 successively widened and strongly transverse, 11 ovate. *Prothorax* about twice as wide as long, apex subtruncate, its angles widely rounded off and depressed, base bisinuate, considerably wider than apex, posterior angles very obtuse, sides arcuately converging to apex, widest near base, and together with the apex distinctly margined; surface strongly, not coarsely nor densely, punctate; basal foveae large and distinct. *Scutellum* large, triangular. *Elytra* widely obovate, wider than prothorax at base, widest at apical third, striate-punctate, punctures in striae large and well separated; intervals very lightly convex and finely punctate; underside rather coarsely and closely punctate; tibiae and tarsi clothed with golden pubescence.

Dim.—5·5 × 2·2 mm. (approx.).

Hab.—New South Wales: East Dorrigo (W. Heron).

Twenty-three examples sent by Mr. Heron. The species is nearest in size and markings to *P. aries* Pasc., in which the ♂ has frontal armature, the antennae and legs are red, the size smaller, also more convex, and the pale markings are interrupted fasciae. *P. pascoei* Macl. is much smaller, with a different elytral pattern, and the underside largely red. In *heroni* the only red on the underside is a small spot on the epipleurae.

Holotype in Coll. Carter.

PLATYDEMA TAYLORI, n. sp.

Ovate, strongly convex, nitid black; antennae and legs reddish-brown.

Head short and wide, epistoma arcuate, its suture ill-defined; eyes not prominent; front densely punctate, antennae short, 1-4 subcylindric, 5-10 successively widened, 11 ovate, much longer than 10. *Prothorax* strongly transverse,

apex and base bisinuate, sides very lightly arcuate, narrowed from base to apex; all angles obtuse, anterior strongly so; disc rather strongly and evenly (not closely) punctate, without medial or other impression, the usual basal foveae obsolete. *Scutellum* large, equilatero-triangular. *Elytra* slightly wider than prothorax at base, ovate and convex, a narrow raised border just perceptible from above; striate-punctate, the small seriate punctures only visible at sides of the two medial interstices; these strongly convex and impunctate. Underside almost impunctate.

Dim.—4 mm. long.

Hab.—N. Queensland: Cairns (F. H. Taylor).

A pair, attracted to light, sent by Mr. Taylor, after whom it is named. The species is separated from the other nitid, all-black species as follows: from *striatum* Montr. by smaller size and convex elytral intervals; from *deplanatum* Champ. by convexity and darker appendages; from *sulcato-punctatum* mihi by less steeply convex and impunctate intervals, besides its unarmed head in both sexes; *laticolle* Macl. besides differing in colour has a wider prothorax, longer and wider antennae. The only two examples seen show no sexual structure.

Holotype in Coll. Carter.

PLATYCILIBE WILSONI, n. sp.

Short and wide, depressed, parallel. Head and elytra reddish-brown, pronotum testaceous; antennae and tarsi red.

Head wide and convex, coarsely punctate, epistoma subtruncate, antennae with three apical segments forming a club, the eighth segment transitional in width between the seventh and ninth. *Prothorax* strongly transverse, apex truncate, except at angles, these rather strongly produced, subacute, but rounded at extreme tips, base truncate, posterior angles a little obtuse; sides straight, their margins entire, just visible from above; disc without medial impression, two foveae near middle, surface covered, not densely, with fine shallow punctures. *Scutellum* oval. *Elytra* of same width as, and closely adjusted to, prothorax, widely rounded behind; striate, scarcely punctate, the wide striae only showing an occasional distinct puncture, intervals wide and nearly flat, coarsely transversely rugulose.

Dim.—5 × 2 mm.

Hab.—New South Wales: Williams River (Lea and Wilson).

A single example on a card shows a distinct species of the form of *brevis* and *integricollis* mihi, but quite unlike either in sculpture as well as colour. Further material may show the elytral brown colour to be due to immaturity. I have been unwilling to remove the specimen from its card to examine the underside. The mandibles, at least the left-hand one, clearly tridentate.

Holotype in Coll. Wilson.

BOLBOPHANES (?) PALLIDIPES, n. sp.

Ovate, very convex; head metallic green, pronotum and elytra metallic black, with a greenish sheen, underside varicolorous (blue, with purple gloss in places); legs and basal two-thirds of antennae pale red or yellow, the apical segments of the latter, also the tarsi, infuscate.

Head rather short and wide; eyes large, round, not prominent; separated by a space wider than a diameter of one eye; antennae just extending to base of prothorax; segments 1-6 sublinear and slender, 7-10 more or less round and

successively larger, 11 ovate, largest. *Prothorax* strongly transverse, apex a little sinuate, front angles advanced but widely rounded; base bisinuate, hind angles subrectangular, sides arcuately narrowed from base to apex; margins horizontally explanate, their surface with transverse rugae, disc lightly convex, with impunctate, mirror-like surface. *Scutellum* equilatero-triangular, very nitid. *Elytra* as wide as prothorax at junction, soon strongly widened behind the rounded humeri, sides subparallel (feebly widened behind middle), very convex, highest point in front of middle, surface rather steeply declivous at base and apex, the basal region slightly flattened behind scutellum, margins invisible from above; rather uniformly but sparsely dotted with minute punctures (visible only under lens); epipleurae with larger punctures, meso- and metasternum closely punctate, abdomen very finely so. Fore and mid tibiae straight and narrow, hind tibiae flattened, curved and widened to apex; fore and mid tarsi considerably enlarged, post tarsi less so, the first and fourth segments of the last about equal in length.

Dim.—9 × 4·5 mm.

Hab.—New South Wales: East Dorrigo (W. Heron). ♀ wanting.

A single example is a puzzling insect to classify generically, the subparallel elytra giving it a more elongate appearance than the other species of the genus. By the method of exhaustion it can only be placed in *Bolbophanes* or in a new genus; but *B. varicolor* Cart. somewhat approaches this form, so that no great outrage is committed by its inclusion.

Type in Coll. Carter.

HEMICYCLUS SPHAEROIDES, n. sp.

♂. Subspherical; above, below and appendages nitid metallic black.

Head short and wide, somewhat engaged in the prothorax, eyes partly covered, these flattish and widely separate; front scarcely visibly punctate, forehead convex, rising steeply from flat epistoma. Antennae slender and linear, extending beyond base of prothorax, apical three segments somewhat rounded, eleventh much the largest. *Prothorax* very short and wide, base about twice as wide as apex, the latter arcuate-emarginate, front angles widely rounded, base arcuate without sinuation, posterior angles obtuse, sides arcuately and strongly narrowed from base to apex, margins sloping downwards, rather widely explanate at base, then narrowing to apex, their surface a little wrinkled; disc mirror smooth, impunctate. *Scutellum* triangular. *Elytra* as wide as long, wider than prothorax at base, humeri obtusely rounded and slightly projecting forward, a narrow explanate margin nearly continuous to, but obsolete at, apex; highest point of convexity at basal third, thence steeply declivous in front, more gradually behind; surface almost impunctate; underside similarly so, epipleurae a little uneven. Hind tibiae slightly arched, tarsi somewhat swollen, first segment as long as, but much wider than, fourth.

Dim.—8·5 × 7·5 mm.

Hab.—North Queensland: Babinda (Mr. J. F. Illingworth).

♀ wanting. This unique specimen is readily separated from *H. réaumuri* Casteln. by its more convex, spherical form, this convexity, longitudinal and transverse, being greater than that of anything in the subfamily Cyphaleinae. The absence of colour is also noteworthy.

Holotype in Coll. Carter.

LEPTOGASTRUS SUTTONI, n. sp.

Elongate-obovate; upper surface, including femora, dark blue, with sparse, upright hairs; underside, tibiae, tarsi, oral organs and antennae castaneous, the apical segments of the last dark.

Head and pronotum coarsely rugose-punctate, the punctures on the former close and round, on the latter forming a reticulation of longitudinal cells; epistoma rounded with subangular protuberance in front of eyes, these little prominent; antennae moniliform, segment 3 longer than 4, thence to 10 successively enlarged, 11 ovoid, wider than 10 and more than twice as long. *Prothorax* cupuliform; apex and base subtruncate, widest at anterior fourth, sides arcuately and considerably narrowed, without sinuation to base, margins not differentiated from disc, extreme border finely crenulate, bearing long setae; anterior angles subrectangular (somewhat blunted) and deflexed, posterior widely obtuse; disc with three depressions, a medial sulcus on posterior third, a smaller longitudinal depression on each side of middle. Abdomen pedunculate. *Elytra* obovate and convex, narrowest at junction with prothorax, widest near apex; punctate-sulcate, with about ten rows of close sulci, containing round punctures forming crenulations at sides of intervals, the latter sharply raised except near suture; sutural interval wide and flat, with some irregularly placed setose punctures thereon. Prosternum, especially at sides, coarsely punctate, abdomen less strongly so. Femora ovoid, post tarsi with fourth segment as long as the rest combined.

Dim.—6 × 2 mm.

Hab.—Queensland: Stanthorpe.

A single example taken by Mr. E. Sutton, after whom I name it, can be readily distinguished from *L. cyaneus* Cart.—the only other blue species—by the different shape of both pronotum and elytra. In *cyaneus* the pronotal angles are markedly dentate, the posterior being emphasized by the lateral sinuation, while the elytra are subcylindric.

Holotype in Coll. Carter.

Cistelidae.

HYBRENIA DENTIPES, n. sp.

♂. Elongate-ovate, black, nitid, pilose; tarsi and the apices of the five exterior segments of antennae castaneous.

Head densely punctate, eyes very transverse, separated by a distance greater than half the diameter of one; antennae sublinear, 3 longer than 4; 4-11 subequal in length, but successively narrower. *Prothorax* rather convex, apex subtruncate (slightly produced in middle), base truncate; widest at, or near, base, thence arcuately narrowed to apex; anterior angles obtuse, posterior subrectangular; disc strongly, uniformly, not densely, punctate, sides clothed with upright red hair, extreme border not visible from above; with three basal foveae, the medial very superficial, those near angles deeper and subtriangular. *Elytra* slightly wider than prothorax at base, and more than thrice as long, sides subparallel for the greater part (or very lightly obovate); striate-punctate, the strial punctures rather small (smaller than in *H. elongata* Macl.), intervals convex, especially on apical half, the sutural four on each containing about two irregular rows of smaller punctures than those in striae, the external intervals containing an irregular single row, the surface rather thickly clad with short upright hair. Underside with close, shallow punctures; front tibiae with a blunt tooth on the inside at basal third.

Dim.—14 × 4·5 mm.

Hab.—N. Queensland: Charters Towers district (Mrs. F. H. Taylor).

Two specimens, both ♂, were captured in a train at night. They are distinguished by the combination of widely separated eyes, convex elytral intervals, and dentate fore-tibiae of the ♂.

Type in Coll. Carter. ♀ latet.

HYBRENIA TIBIALIS, n. sp.

♂. Subparallel, nitid black, glabrous; oral organs, antennae and legs castaneous.

Head sparsely punctate, eyes large, prominent and subcontiguous, antennae with segment 3 longer than 4, both very slender, 5-10 subequal in length, very gradually and successively widening, 11 shorter and wider than 10. *Prothorax* convex, apex and base subtruncate, sides rounded in front, anterior angles quite rounded off, rather strongly sinuate behind, posterior angles subrectangular, disc minutely punctate, with wide medial depression and a wide basal transverse depression as well as a basal sulcus within the raised border (lateral border unseen from above). *Elytra* wider than prothorax at base and about three and a half times as long, striate-punctate, the intervals convex and impunctate, the striae containing large oval punctures continued with very slight diminution of size to extreme apex; sternal area moderately punctate, abdomen almost impunctate; hind tibiae bent inwards and downwards on basal half, thence widened and fringed beneath with pale hairs.

Dim.—17 × 5 mm.

Hab.—N. Queensland: Ravenshoe (H. J. Carter).

I took a single ♂ example in June, 1921. It is like, in form and sculpture, *H. nitidior* Cart., from which it may be distinguished by its red legs and the remarkable hind tibiae, the more convex prothorax and the elytral seriate punctures continuous to apex.

Holotype in Coll. Carter. ♀ wanting.

Since the number of species of *Hybrenia* is nearly twice as many as when my former table was published (*Proc. Roy. Soc. Vict.*, 1915, p. 85), I append a revised tabulation.

Table of *Hybrenia*.

1.	Colour black, or nearly so	2
	Elytra with alternate intervals red	*vittata* Pasc.
	Colour red or yellow	22
2.	Appendages dark	3
	Appendages clear red or yellow	19
3.	Elytral intervals flat	4
	Elytral intervals convex	6
4.	Surface glabrous	*sublaevis* Macl.
	Surface pilose or pubescent	5
5.	Elytral striae distinct throughout	*pimeloides* Hope
	Elytral striae only discernible on apical half	*substriata* Cart.
6.	Elytral intervals sharply raised (subcostate)	7
	Elytral intervals rounded or little raised	8
7.	Pronotum very nitid and sulcate, form slender	*subsulcata* Macl.
	Pronotum opaque, rugose, scarcely sulcate, form robust	*rugicollis* Cart.
8.	Surface glabrous	9
	Surface pilose or pubescent	12
9.	Pronotum subopaque, much narrower than elytra	*angusticollis* Cart.
	Pronotum nitid, not much narrower than elytra	10

10. Pronotum impunctate ..... *nitidior* Cart.
    Pronotum punctate 11
11. Size large (20 × .7½ mm.), elytral seriate punctures large and square ..... *laticollis* Macl.
    Size smaller (15 × 4½ mm.), elytral seriate punctures much smaller ..... *angustata* Macl.
12. Protibiae of ♂ dentate or widened in middle 13
    Legs without sexual characters 14
13. Eyes approximate, protibiae of ♂ subdentate in middle ..... *nitida* Blkb.
    Eyes widely separated,* protibiae of ♂ dentate at basal third ..... *dentipes*, n. sp.
14. Eyes approximate 15
    Eyes widely separated 17
15. Elytral intervals very lightly raised, surface lightly pubescent 16
    Elytral intervals well raised, surface strongly pilose ..... *pilosa* Cart.
16. Pronotum and elytral intervals moderately punctate ..... *elongata* Macl.
    Pronotum and elytral intervals more densely punctate ..... *torrida* Cart.
17. Surface thickly pilose, strial punctures commingled with interstitial ..... *occidentalis* Cart.
    Surface lightly pubescent, strial punctures clearly distinct from interstitial 18
18. Surface very nitid, pronotum sulcate ..... *illidgei* Cart.
    Surface less nitid, pronotum non-sulcate ..... *yeppoonensis* Cart.
19. Femora with apical two-thirds testaceous ..... *femorata* Cart.
    Legs red 20
20. Surface pilose ..... *planata* Cart.
    Surface glabrous 21
21. Size very large (23-25 mm. long), eyes widely separated ..... *grandis* Borch.
    Size smaller (17 mm. long), eyes approximate ..... *tibialis*, n. sp.
22. Colour pale yellow, glabrous ..... *pallida* Cart.
    Colour castaneous, pilose ..... *horni* Cart.

* Eyes widely separated means that the space between them is at least equal to half the diameter of one.

Cerambycidae.

Mesolita alternata, n. sp.

Elongate, subcylindric, densely pubescent; head and pronotum black, the former moderately, the latter thickly, clad at base and apex with white recumbent pile, medial area largely glabrous; elytra with alternate and subequal transverse bands of white and black, the base, middle and apical bands white, the rest black, antennae and legs reddish, the segments of the former darker at apices, though scarcely annulate.

Head finely punctate, antennae longer than body, segment 3 much longer than 4; 4-10 successively shorter, 11 showing a short compressed pseudosegment. *Prothorax* elongate-ovate, longer than wide, very slightly enlarged in middle, apex a little produced in middle and slightly wider than base; finely punctate and longitudinally strigose on dark medial area. *Scutellum* smaller than usual, scarcely distinguished from surroundings by dense clothing. *Elytra* subcylindric, very lightly widened behind middle, of same width as prothorax at base, apices separately subdentate (i.e., produced without being definitely acute or rounded); some punctate striae traceable, seen more clearly on dark areas; two short nude lines on basal white area.

Dim.—5 × 1·5 (circiter) mm.

Hab.—Queensland: Kuranda (G. E. Bryant).

A single example (Holotype) in British Museum may readily be distinguished from the only three species having the apices unarmed, namely, *inermis* Pasc., *myrmecophila* Lea and *transversalis* Pasc., by its different pattern, subcylindric form and very dense pubescence.

MESOLITA ANTENNALIS, n. sp.

Head and pronotum black, irregularly clad with silvery pubescence, elytra bronze-brown with pale markings, these more strongly pubescent than the rest and consisting of a short white fascia at apical third, extending about half-way across elytra, this rather narrowly produced behind along suture to apex; some sparse, irregular, pale, pubescent spots along side and on basal third; antennae and tibiae variegated, the former with base of all segments from the second and a middle ring of segments 3-7 testaceous, the rest dark brown; apices of femora and middle ring of tibiae testaceous.

Head: Antennae slightly longer than body and stoutly cylindric; segment 3 much longer than 4; 4-11 successively shorter. *Pronotum* scarcely longer than wide, ovate, widest near apex, narrowest at base; punctate and finely, longitudinally strigose on apical half. *Scutellum* large and rounded behind. *Elytra* obovate, of same width as prothorax at base, rather widely rounded behind middle, each apex subangulate in middle; a line of large punctures near suture on basal third, an irregular raised impression on each near base having foveate punctures thereon; dark area with some irregular, elongate scratches, surface thinly and unevenly clad with silvery pubescence.

Dim.—5 mm. long.

Hab.—New South Wales: Barrington Tops (H. J. Carter).

I took a single example in January, 1927. In form and size near *inermis* v.d. Poll., it is distinguished by a quite different elytral pattern and apical structure, as also by its variegated antennae and tibiae. It is gummed on cardboard and I have been unwilling to remove it to examine the underside.

Holotype in Coll. Carter.

NOTES ON THE IDENTITY OF DESCRIBED AUSTRALIAN FLIES OF THE GENUS *CERDISTUS* (ASILIDAE).

By G. H. Hardy.

(Two Text-figures.)

[Read 24th April, 1929.]

In Macquart's *Diptères Exotiques*, fourth supplement, 1849, there are about one hundred and forty descriptions of flies recorded from Tasmania. It has long been evident that this locality is erroneous in many cases, whilst recent researches have led me to believe that probably throughout this portion of Macquart's work the locality is not correct. I have dealt with this matter in a separate paper (see above, pp. 61-64) and now apply the view to the genus *Cerdistus*.

According to the identification of species and the synonymy hitherto standing, Macquart described seven of the ten species belonging to the genera *Cerdistus* and *Neocerdistus*, that are known to occur in Tasmania. This very high proportion of the known fauna of that area, which has been intensively collected over since, greatly exceeds the probable collecting ability of widely engaged collectors like the Verreaux Brothers must have been, or else this fauna must have greatly exceeded the numbers now found in that island, or the collectors must have spent more years there than they seem to have done. White, who made a special effort to discover these flies, apparently missed two of them, and I missed two myself during five years' residence in that State.

Again it seems incredible that Macquart's descriptions of some of the island forms should be readily recognizable, whilst others, all published in the fourth supplement, cannot be applied to Tasmanian forms without allowing a certain latitude for apparent inaccuracies. Moreover it now transpires that mainland forms conform to these latter descriptions more satisfactorily than do the island forms.

By a comparison of Macquart's and other early descriptions, it will be noted that the naming of the colours brown, black, grey and yellow are used in an inconsistent manner. I have largely used my discretion when these confusions are met with, so it becomes necessary to point out that no specimens known to me having yellowish or brownish femora, with or without a black stripe, are ever black, but invariably are brown in ground colour. Specimens having femora mainly black, that is the black is not restricted to a stripe, almost invariably have the ground colour black. In rare cases, as on *C. volaticus* White, there is a brownish sheen over the black and it is quite perceptible on the abdomen when in good condition; I think this is one of the characters that led White to place *C. volaticus* in his *Rhabdotoitamus*.

Macquart described 28 species of Australian Asilidae in his fourth supplement, and of these eleven are attributed to the mainland: *Dasypogon aurifacies*, a synonym of *Thereutria amaricus* Walker; *Dasypogon diversicolor*, another

synonym of the same; *Codula limbipennis; Laphria ornatipennis; Asilus fulvipubescens*, which is a *Cerdistus; Ommatius angustiventris; Asilus ferrugineiventris*, a *Neoaratus*, also, but erroneously, recorded from Tasmania.

Hitherto the following were unrecognized: *Laphria fulviceps*, which is doubtfully Australian; *Erax albiventris*, having wings dilated on the anterior border, may be *Neoaratus* or *Ommatius*; **Asilus nigrinus*, name preoccupied by Macquart, 1848; *Asilus ruficoxatus*; *Asilus exilis*, previously described from Kangaroo Island.

Those recorded from Tasmania are: *Dasypogon flavifacies*, a *Stenopogon*, certainly not Tasmanian; *Dasypogon maculinevris*, an *Erethropogon*, found from Tasmania to Queensland; *Dasypogon rubrithorax*, a synonym of *Cabasa pulchella* which has almost the same range; *Codula fenestrata*, recognized by Ricardo from the mainland, and by White from Tasmania; there may be a complex in this species of *Brachyrrhopala*; *Ommatius dimidiatus*, known only from the mainland; *Gonyptes geniculatus*, recognized by Ricardo from the mainland and by White from Tasmania—there may be a complex here, too; it is a *Leptogaster*.

Four species were identified from Tasmania on the understanding that this was the type locality: *Laphria niveifacies*, of which the determination is not satisfactory; **Asilus varifemoratus*, erroneously placed as a synonym of *C. margites* Walker; **Asilus mystipes*, erroneously suggested as a synonym of *C. graminis* White; **Asilus cognatus*, erroneously placed as a synonym of *C. vittipes* Macq.

There are four further names that have hitherto remained outstanding: *Dasypogon analis*, suggested as a synonym of *Saropogon suavis* Walker, by Ricardo; *Dasypogon nigrinus*; *Laphria flavifemorata*; **Erax asiloides*.

By substituting Sydney for Tasmania in all these cases, it will be found that many descriptions fit certain species from the former locality very much better than those from Tasmania. Those species marked with an asterisk (*) are dealt with in the present paper.

Cerdistus fuscipennis Macquart.

Erax fuscipennis, Macquart, *Dipt. Exot.*, 1, ii, 1838, 109; Walker, *List Dipt. Brit. Mus.*, vii, suppl. 3, 1855, 643; Ricardo, *Ann. Mag. Nat. Hist.*, (8) xi, 1913, 420.—*Erax asiloides*, Macquart, *Dipt. Exot.*, suppl. 4, 1849, 82; Ricardo, *Ann. Mag. Nat. Hist.*, (8) xi, 1913, 420.—*Cerdistus constrictus* Hardy, Proc. Linn. Soc. N.S.W., li, 1926, 654.

Synonymy.—When describing *Cerdistus constrictus*, I drew attention to the fact that this species was large, widely dispersed and very abundant; I also pointed out that it seemed incredible that the species has not been described before. It would appear, however, that Macquart placed it in the genus *Erax* on two occasions. Hitherto I have been unable to identify outstanding species placed in *Erax*, but now that it becomes evident that *Erax asiloides* was from Sydney, not Tasmania, undoubtedly that name must be applied as above; according to Ricardo the type is lost. Thinking other species of that genus may also belong to *Cerdistus*, I re-examined the descriptions and found "Thorax à bandes noires, séparées par du jaune doré" given under *E. fuscipennis*. That character immediately suggested the male of *C. constrictus*, and on comparing the rest of that short description I found it suited specimens very favourably. Neither *fuscipennis* nor *asiloides* is a suitable name for this magnificent *Cerdistus*, the only Eastern Australian species known to me that ever exhibits the golden yellow colouration

on the thorax; the corresponding colour on other species is invariably ashy grey or brown, at most with a strong tinge of yellow.

Cerdistus maculatus White.

Neoitamus maculatus, White, *Proc. Roy. Soc. Tasmania*, 1913, 278; Hardy, Proc. Linn. Soc. N.S.W., xlv, 1920, 201.—*Machimus forrestii* Dakin and Fordham, *Ann. Mag. Nat. Hist.*, (9) x, 1922, 529, Pl. xv, fig. 4; Hardy, *Ann. Mag. Nat. Hist.*, (9) xii, 1923, 176.

Synonymy.—I have already drawn attention to the probability that *Machimus forrestii* D. and F., is a synonym of the rather widely dispersed Western Australian *N. maculatus*, but I did not care at the time to place this view more than as a suggestion. Since then I have seen more species of the genus from that State, and two of these also have spotted wings. The two latter forms are in the Ferguson Collection and are beautiful species with much golden tomentum and the legs are brightly variegated in colour, unlike the present species whereon they are dark (black and dull reddish). The larger of the two new species has the genitalia comparable to those of *C. gibbonsi* Ricardo, and is one of several links where I have found similarities in structure coupled with widely different colour characters between allied faunas of Eastern and Western Australia. The male of *C. maculatus* White is still unknown, but the female is represented in various collections, and judging from Dakin and Fordham's short description their specimen must be yet another.

Cerdistus margitis Walker.

Asilus margitis Walker, 1849.—*Cerdistus margitis*, Hardy, Proc. Linn. Soc. N.S.W., li, 1926, 656 (which see for further references and synonymy).—*Asilus nigrinus*, Macquart, *Dipt. Exot.*, suppl. 4, 1849, 93 (preoccupied, Macquart, 1848).—*Cerdistus australis* Ricardo, *Ann. Mag. Nat. Hist.*, (9) i, 1919, 62.

Synonymy.—*Asilus nigrinus* Macquart, was used for a Brazilian fly in 1848. From the description of the fly described under the same name in 1849, it is very probable that Macquart had the present species before him; the description is inadequate for absolute determination but such characters as are given conform to this very abundant species. In the text under this specific name (reference above), I suggested that *Cerdistus australis* Ricardo was also a synonym; there is a paratype in the Gibbons collection from the Ricardo series that confirms this. *Asilus varifemorata* Macquart, 1849, is now removed from the synonymy of this species, for it apparently should take precedence over *C. volaticus* White, for particulars of which see below.

Cerdistus maricus Walker.

? *Asilus australis*, Macquart, *Dipt. Exot.*, suppl. 2, 1847, 44; Walker, *List Dipt. Brit. Mus.*, vii, suppl. 3, 1855, 737.—*Asilus maricus*, Walker, 1851.—*Cerdistus maricus*, Hardy, Proc. Linn. Soc. N.S.W., li, 1926, 651 (which see for references and synonymy).

Synonymy.—Of all those species I am able to recognize and name, the short description of *Asilus australis* Macq., can only apply to this common form, whilst it does not conform to those still remaining unnamed in my collection. Although having priority, I do not intend using Macquart's name at present. Ricardo subsequently used "*australis*" for two other species.

Cerdistus gibbonsi Ricardo.

Neoitamus varius, Ricardo, *Ann. Mag. Nat. Hist.*, (8) xi, 1913, 431 (part).—*Neoitamus vulgatus* var. (New South Wales), White, *Proc. Roy. Soc. Tasmania*, 1916, 178.—*Neoitamus gibbonsi*, Ricardo, 1918.—*Cerdistus gibbonsi*, Hardy, Proc. Linn. Soc. N.S.W., li, 1926, 652 (which see for references and synonymy).

Synonymy.—Ricardo had a complex under the name *N. varius*, which was originally applied to a New Zealand species, and it would appear that the present species is one of them, a specimen being so named by her in the Gibbons collection. *Cerdistus vulgatus* Macquart which is limited to Tasmania, was another form in that complex, but White recorded a variety under the name *vulgatus* from New South Wales, which again seems to be the present species. The median undivided stripe on the thorax and the two scutellar bristles of White's so-called variety, certainly suggest *C. gibbonsi* Ricardo, and in my note a specimen labelled by White I drew attention to the long ovipositor which makes the determination more assuredly correct.

Rhabdotoitamus White.

White, *Proc. Roy. Soc. Tasmania*, 1917 (1918), 95.

White used this name for all Australian species that were mainly brownish in colour and he included at least one other. The main feature, as White understood the group, was the striped femora and the light brown body; I have already pointed out that it was not a homogeneous group within the genus *Cerdistus*, as colour has no significance in this respect, but nevertheless aids in the identification of species. In the present paper the group is revised mainly for the purpose of establishing the presumed identity and status of *mistipes* and *cognatus*, advantage being taken to describe more fully *Rhabdotoitamus volaticus* White which, hitherto, was unrecognized by me and has very little of the typical *Rhabdotoitamus* appearance.

Key to the species of Cerdistus *that come within the concept* Rhabdotoitamus *White.*

1. Moustache mainly black; genitalia of female short and simple, upper forceps of male with a process; thoracic stripe narrowly and faintly divided. A brownish species ..... *lautus* White
   Moustache of male mainly white, at most with only a few black hairs; of female similar or rarely mainly black 2
2. Femora entirely black; female genitalia short, simple; median stripe of thorax undivided. A brownish species (Tasmania) ..... sp.
   Femora not entirely black 3
3. Thoracic stripe conspicuously divided. Brownish species. Upper forceps of male genitalia with a process 4
   Thoracic stripe undivided; upper forceps of male genitalia simple, without process; female ovipositor usually short 6
4. At least intermediate and posterior femora always black at apex. Sixth and seventh segment of abdomen ovipositor-like in colour and structure, ovipositor itself longer than usual 5
   Femora with a distinct black stripe that does not reach the apex. Ovipositor short. ..... *vittipes* Macquart
5. Femora without stripe, antennae light coloured, male genitalia always black ..... *fulvipubescens* Macq.
   Intermediate and posterior femora with or without a stripe; antennae black, male genitalia always light coloured; moustache of female may be mainly black .... *rusticanoides* Hardy
6. A black species. Femora only light coloured at base, no conspicuous stripe. Ovipositor longer than usual ..... (? *varifemoratus* Macquart), *volaticus* White
   Brown species; femora always light coloured and always with a stripe well defined 7

7. Stripe extending to the base of at least the two posterior femora 8
Stripe only extends to about half the length of the femora, not reaching the base ..... *mistipes* Macquart
8. Bristles behind the eyes black (New South Wales) ..... sp.
Bristles behind the eyes yellow ..... *cognatus* Macquart

There are two species left unnamed in the above key; one from Tasmania bears a label written by Dr. A. J. Turner, and is a female from Cradle Mt. Road, 2,000 feet; the other species, from New South Wales, has much in common with *C. volaticus*, even in regard to the structure of the genitalia, but the femora are distinctly striped. There are many characters that distinguish it from *mistipes* and *cognatus*, but most of them are somewhat trivial; the male genitalia have the upper forceps very much broader than either of these and the femoral stripe covers a wider area; it may be *C. graminis* White, one of the two omitted from this account. The other outstanding species, *C. rusticanus* White, from Victoria, is definitely not *rusticanoides* to which the description best conforms, but possibly it is *C. fulvipubescens* Macq., a species that sometimes has the femora darkened above but never forming a typical stripe.

Cerdistus lautus White.

Rhabdotoitamus lautus, White, 1917.—*Cerdistus lautus*, Hardy, Proc. Linn. Soc. N.S.W., li, 1926, 651.

Hab.—Originally described from Victoria, and subsequently recognized by me from that State, I am now including eight specimens from New South Wales, having their genitalia of the same general structure and other characters agreeing with the published description, except that the ground colour of the abdomen is not black, as White states, but brownish. Sydney, 1 male, 31.3.18; Blue Mts., 4 males and 3 females, January, 1922 and 1926.

Cerdistus vittipes Macquart.

Asilus vittipes, Macquart, 1847.—*Neoitamus vittipes*, Hardy, Proc. Linn. Soc. N.S.W., xlv, 1920, 195 (which see for further references and synonymy).

Synonymy.—*Asilus cognatus* Macquart is now removed from the synonymy of this species where it was placed on the understanding that the type was from Tasmania.

Hab.—Previously recorded from Tasmania, Victoria and New South Wales, the ascertained range of this species is now extended to Queensland. A pair was taken *in copula* at the National Park, March, 1921, also from Brisbane, 1 male, April, 1923, and 1 female, October, 1922.

Cerdistus rusticanoides Hardy.

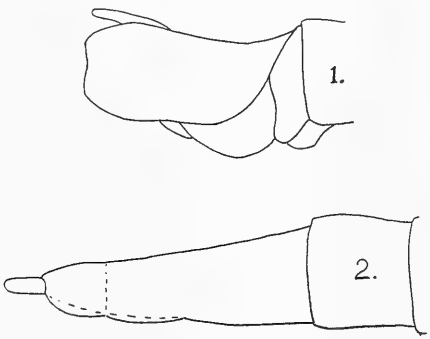
Hardy, Proc. Linn. Soc. N.S.W., li, 1926, 649.

Hab.—Previously recorded from Victoria, the species is now represented by two males from South Australia, Mt. Lofty, 31.12.21 (C. E. Cole). One of these has a well marked stripe on the intermediate and posterior femora. On neither does the basal swelling on the upper forceps show at all clearly, but it is there, as can be demonstrated by the presence of the groove that marks the apex of the swelling. From *C. fulvipubescens* it can be distinguished by the upper forceps being much broader in proportion to their length.

CERDISTUS VOLATICUS White. Text-figs. 1 and 2.

? *Asilus varifemoratus*, Macquart, *Dipt. Exot.*, suppl. 4, 1849, 95; Ricardo, *Ann. Mag. Nat. Hist.*, (8), xi, 1913, 449.—*Neoitamus graminis* var., White, *Proc. Roy. Soc. Tasmania*, 1916, 179.—*Rhabdotoitamus volaticus*, White, *Proc. Roy. Soc. Tasmania*, 1917 (1918), 97.

Synonymy.—At present it is impossible to suggest with assurance a position for *Asilus varifemoratus* Macquart; it might be any small blackish species of *Cerdistus* with a white moustache, the posterior femora having a quarter of their length brown; such characters would fit the present species on which the brown colour of the femora is variable in extent. The white pubescence, hairs and bristles, referred to by Ricardo as occurring on the type, also strongly indicate the present form. White's name is used in the present instance, as this certainly applies to the one described below.



Text-figs. 1, 2.—*Cerdistus volaticus* White. 1, hypopygium of the male; 2, ovipositor of the female.

Description.—Male. The moustache and tubercle are small, the former entirely white; postocular bristles white. The dorsal thoracic bristles are disposed on each side of the median line as follows: Two presutural, one supraalar, one postalar, three well defined dorsocentrals and two or three small bristles anterior to them. One pair of scutellars, metapleurals present, hypopleurals absent or practically so. Nearly all these bristles are white. The abdomen has about three conspicuous white lateral bristles on most segments. The femoral bristles are entirely white and many are often missing, the ventral row on the posterior pair being most in evidence. The male genitalia are simple, the upper forceps are more than twice as long as their greatest width, the apical border is slightly emarginate, the lower forceps reach to about half their length.

The female is similar, the ovipositor not quite as long as the three anterior segments.

Hab.—Victoria: Melbourne, a pair *in copula* and a female in Mr. Erasmus Wilson's collection, December, 1927, and January, 1928; Fern Tree Gully, 2 males, January, 1922. New South Wales: Sydney, Blue Mts., November to January, 1920-1926, a long series of both sexes. Queensland: Brisbane, October to December, 1926 to 1928, a long series of both sexes.

Observations.—In common with many others of the genus, this species rests on dead twigs, awaiting prey, and it occurs sometimes in such numbers that

scarcely a tree is without one or two; a suitable locality for collecting them is in the bush adjacent to cultivated land, where they prey upon small beetles of the family Scarabaeidae and weaker insects. One female had as prey, a flying ant to which was attached a minute male *in copula*; the prey were fulfilling their function despite the condition.

I have already given two keys for the determination of species of *Cerdistus* recognized by me, and in order to incorporate the present form, it is necessary to amend the keys in the following manner: Hardy, 1926, pp. 648 and 649.

For couplet 13 of key based on both sexes, *read*:

13. Supra- and postalar bristles one each ..... 13*a*.
Two supra- and one postalar bristles; a small black species from Tasmania ..... *laticornis* Macq.

13*a*. Brown species, femora with a conspicuous black stripe ..... *claripes* White, and *neoclaripes* Hardy.
Black species, femora mainly black, but generally reddish at base ..... *volaticus* White.

For couplet 16 of key based on females, *read*:

16. Small black species with black legs; from Tasmania ..... *laticornis* Macq.
Black or brown species, legs never entirely black 17

17. Femora brown, with a conspicuous black stripe ..... *claripes* White, and *neoclaripes* Hardy.
Femora mainly black, reddish-brown only at the base ..... *volaticus* White.

Cerdistus mistipes Macquart.

Asilus mistipes Macquart, *Dipt. Exot.*, suppl. 4, 1849, 94 (*nec* Ricardo, White, Hardy).—*Rhabdotoitamus claripes*, White, 1917.—*Cerdistus claripes* Hardy, Proc. Linn. Soc. N.S.W., li, 1926, 653 (which see for further references and synonymy).

Synonymy.—On the assumption that *Asilus mistipes* Macquart was from Tasmania, the name was given by me as taking priority over *N. graminis* White, a form known to me only from description. Now that it becomes apparent that the species originally came from Sydney, there are only three known forms to which the name can be applied; *C. claripes* White, *C. neoclaripes* Hardy, and *C.* sp. referred to in the key. The last mentioned has a few black hairs on the moustache and, in addition, in common with *C. neoclaripes*, the stripe on the intermediate and posterior femora reaches to near the base. Macquart described these stripes as "Cuisses à extremité noire, cette couleur se prolongeant en ligne vers la base du coté extérieur". The word "vers", as opposed to say "jusqu'à", would indicate the character of *claripes* rather than *neoclaripes*, so I would suggest that *mistipes* and *claripes* refer to the same species.

Further, it will be noted, Macquart described the male, whilst Ricardo states that the type is a female. Ricardo described a male and a female under the name *mistipes* from South Australia, the specimens being previously compared with the female type referred to by her. In the description she states: "ovipositor long, the last two segments included in it". This structure of the ovipositor can only indicate *C. fulvipubescens* and *C. rusticanoides*, the latter of which is known from that State. I would suggest the so-called type seen by Ricardo is *C. fulvipubescens*, and her South Australian species was the very closely allied *C. rusticanoides*.

Confirming a previous conclusion, that *Neoitamus australis* Ricardo is a synonym of the present species, there is one of the Gibbons collection bearing Ricardo's specific name (see notes on this collection given below).

CERDISTUS COGNATUS Macquart.

Asilus cognatus, Macquart, *Dipt. Exot.*, suppl. 4, 1849, 94.—*Neoitamus neoclaripes*, Hardy, PROC. LINN. SOC. N.S.W., xlvi, 1921, 295.

Synonymy.—*Asilus cognatus* Macquart, the type of which is apparently lost, was placed by me as a synonym of *C. vittipes* Macquart, on the understanding that the species was from Tasmania. Now that the type locality is considered to be more certainly Sydney, it becomes evident the name may apply to *C. neoclaripes* Hardy. The character: "Face et moustache blanches; cette dernière s'élévant jusqu'à la moitié de la face", in conjunction with "tarses noires", would indicate this. In outlining the foregoing characters pertaining to the distinction between *mistipes* and *cognatus*, it seems advisable to state that my notes are based on limited material. The males can always be recognized, the genitalia in each case being distinctive enough for the purpose of certain recognition. The difficulty is with the females, as I have no means of telling how far the characters remain constant. When identifying material in collections, I use the names *claripes* and *neoclaripes*, attaching these to males only, for if the characters are consistent with the above account, then *claripes* female, described by White, is *neoclaripes*, and such females previously named by me will need revising.

Hab.—The species was previously recorded from Sydney and environs, but it is represented by a small series from South Australia, Mt. Lofty, 2 males and 3 females, 31.12.21. Mr. C. E. Cole sent these to me at the time of capture; it was only when preparing the revision of this group that their identity became recognized. The male genitalia do not show that slight upwardly directed attenuation of the upper forceps as clearly as on the Sydney specimens, but they are of the same length and all the other characters agree.

Revised synonymic list of Tasmanian Cerdistus.

C. flavicinctus White, Hardy.
vittipes Macquart, Hardy; *brunneus* White.
fraternus Macquart, Hardy; *luctificus* Walker; *vulgatus* White.
gibbonsi Ricardo, Hardy; *hyalipennis* White, *nec* Ricardo.
rudis (Walker), White, Hardy.
armatus Macquart, Hardy; *setifemorata* Macquart.
margitis Walker, Hardy; *calliginosus* White.
laticornis Macquart, Hardy.
graminis White.
sp. Hardy.

Owing to matters dealt with in the foregoing discussion on the identity of species, the list of Tasmanian *Cerdistus* previously given by me needed revision. With necessary alterations and additions this is given above. There is some doubt if the name *C. rudis* Walker is truly applicable to the form so recognized by White, and there may also be a complex standing under the name *C. armatus* Macquart, but in the other cases the names will probably remain permanently.

Notes on the Gibbons collection of Cerdistus *in the Australian Museum.*

The species of *Cerdistus* as isolated in this collection are twenty-three in number. Those bearing new specific names in the Gibbons manuscript are marked with an asterisk, others he did not name but attached numbers corresponding to the numbers on the pins. The new names are not produced here as their publication is undesirable and the numbers are adequate enough for the purpose of this list.

Cerdistus australis Ricardo, paratype = *C. margitis* Walker.
Neoitamus varius, labelled by Ricardo = *C. gibbonsi* Ricardo.
Neoitamus gibbonsi Ricardo, probably part of the [illegible] series.
Neoitamus hyalipennis Ricardo, = *C. setosus* Hardy. This was probably identified by Gibbons himself, for the determination scarcely seems right; *hyalipennis* has the transverse vein (r-m) situated at two-thirds the length of the median cell, whilst on *setosus* it is before the middle of that cell; also the moustache would contain more black hairs and the scutellar bristles should be white on *hyalipennis*.
Neoitamus caliginosus White, correctly identified.
Neoitamus brunneus White, also correct.
**Neoitamus* sp. No. 27 = *C. vittipes* Macquart.
Neoitamus sp. No. 29, not recognized.
Neoitamus sp. No. 46, also unrecognized.
Neoitamus sp. indet. = *C. margitis* Walker.
**Neoitamus* sp. No. 5 = *C. constictus* Hardy = *C. fuscipennis* Macquart. This is the form to which Gibbons gave the name *"grandis"*, and was referred to by me when describing it.
**Neoitamus* sp. No. 23 = *C. fuscipennis* Macquart.
Neoitamus sp. No. 15 = *C. gibbonsi* Ricardo, and *C. conformis* Hardy; both are under this number.
Neoitamus sp. No. 32, not recognized.
Neoitamus sp. No. 45. This is a small black species, the female having the 6th and 7th segments of abdomen black and subcompressed; it appears to be undoubtedly new but was left unnamed by Gibbons.
***Neoitamus* spp. These are two further species in the manuscript named as new, and I have no note of their number. The types were not found by me.
**Paritamus australis*. Presumably a species sent to Ricardo and subsequently described by her as *Neoitamus australis*, keeping the specific name proposed by Gibbons = *C. claripes* White.
**Paritamus* sp. No. 10, not recognized.
Paritamus sp. No. 12 = *C. gibbonsi* Ricardo.
Paritamus sp. No. 33 = *C. gibbonsi* Ricardo.
Dysmachus sp. No. 9 = *C. setosus* Hardy.
Dysmachus sp. No. 42 = *Neocerdistus* sp. (? *ombrabatus* Walker).

The history of the Gibbons collection, of which the above is a part, is to be given elsewhere. Gibbons recognized three genera in the *Cerdistus*-complex, but unfortunately he gave no indication as to how he distinguished between them. It will be noted that *Cerdistus* is used only in one case, a specimen being identified by Ricardo as such, but *Paritamus*, *Dysmachus* and *Neoitamus* were certainly used by him. Evidently his system in the classification was based on artificial characters as he had *C. gibbonsi* under two genera. It is of interest to note that Gibbons attached small sketches of the hypopygia to the pins of certain specimens, indicating the fact that he took notice of this structure in his studies.

Amendments.

In Hardy (These Proceedings, li, 1926, p. 648) will be found a list of specific names belonging to the species of *Cerdistus* and *Neocerdistus* that were not placed at that time. *Asilus mutilatus* Walker was inadvertently inserted; it is a *Bathypogon*. *Neoitamus graminis* White was omitted.

Of the twenty names thus amended, six have since been recognized, five in the present paper, the sixth having been dealt with earlier and placed as a synonym of *C. fulvipubescens* Macquart, with certain reservations. In the discussion on that synonym, namely *Glaphyropyga australasiae* Schiner (Hardy, These Proceedings, lii, 1927, p. 392) the word "description" in line 18 should read "translation."

There are now 55 names under the genus *Cerdistus*, of which 20 are recognized as valid, 22 are relegated to synonymy, and 13 are still outstanding.

PRELIMINARY NOTE ON MONZONITIC AND NEPHELINE-BEARING ROCKS OF MOUNT DROMEDARY, N.S.W.

By Ida A. Brown, B.Sc., Linnean Macleay Fellow of the Society in Geology.

[Read 27th March, 1929.]

The occurrence of plutonic igneous rocks at Mount Dromedary, on the South Coast of New South Wales, about 250 miles south of Sydney, has been known for many years past, although no detailed examination of them has been made until recently. In the year 1892, W. Anderson published an account of their occurrence, describing certain types under the headings of "Hornblendic Granite", "Augite Granite" and "Augite-Felspar-Mica Rock", and brief reference to other varieties was made by H. I. Jensen in a report to the Australasian Association for the Advancement of Science, 1911.

More detailed investigations being carried out by the writer at the present time show that these rocks are members of a monzonitic plutonic complex, in which acid, intermediate, basic and ultra-basic phases are represented by banatite, monzonite, olivine-monzonite, kentallenite and pyroxenite. As a further result of differentiation of the monzonitic magma a number of rare and interesting alkaline rock-types have also been produced, including shonkinite and a series of nepheline-bearing plutonic rocks, ranging from nepheline-monzonite and nepheline-shonkinite to types approaching jacupirangite and other members of the alkali-gabbro subfamily, whose exact identity has not yet been fully determined.

Associated with the monzonitic series, and probably genetically related to it, is a series of peculiar eucritic rocks containing varying amounts of garnet.

Hypabyssal equivalents of the monzonites also occur in the district; representatives of both the plutonic and hypabyssal groups outcrop on Montague Island, a few miles off the coast near Mount Dromedary.

In certain localities in this State quartz-monzonites occur on a small scale as local phases of granitic intrusions, and a quartz-monzonite, discovered by E. C. Andrews (1901) at Kiandra, has been described in detail by W. R. Browne and W. A. Greig (1922). Hypabyssal equivalents of the monzonites from Milton were described in 1905 and 1915 by G. W. Card, and subsequently (1925) in more detail by the writer; the Permo-Carboniferous flows of the coastal portion of the Southern Coalfield are also derivatives of a monzonitic magma, but so far as the writer is aware, this is the first record of a complete series of plutonic monzonitic rocks in this State or in Australia.

The rock shonkinite, whose occurrence in Australia is recorded here, also for the first time, is an interesting type of considerable importance in theoretical petrology, although it is known to occur only in a few places in the world, the total area of all known outcrops being about twenty square miles, according to Daly (1914). Jacupirangite and its associated types are even rarer.

The mineral nepheline has not hitherto been recorded from a truly plutonic rock in New South Wales, or even, so far as the writer is aware, in Australia. The so-called "nepheline-syenite" near Dubbo, quoted by R. A. Daly, is a fine-grained sölvsbergite in the form of a volcanic plug, according to H. I. Jensen, who infers for it a Post-Triassic age; the "nepheline-syenite" at Minnamurra is a similar fine-grained rock of uncertain age, occurring as a sill in Permo-Carboniferous beds.

The variety of unusual rock-types which occur in the Mount Dromedary District, and the peculiar association of saturated and under-saturated rocks, some containing quartz, and others containing olivine and/or nepheline, make this area one of particular interest in Australian geology, and of importance in the science generally.

The series is of further interest on account of its geological age; all recorded occurrences of alkaline rock-series containing felspathoids in Eastern Australia are hypabyssal or volcanic series of Cainozoic age, whereas the available evidence indicates that the injection of the complex monzonitic intrusion of the Mount Dromedary District probably took place in late Palaeozoic time.

The intrusion, or series of intrusions, has been injected into a highly folded series of quartzites and slates, and has seriously affected their direction of strike, besides producing in them certain changes due to contact metamorphism. As a result of field-work it has been found necessary to modify Anderson's map showing the outer boundaries of the igneous series, and also to indicate the outcrops of the differentiated types. The differentiation of the magma has been a very complicated process, and the relationships of its products appear even more complex on the geological map, owing to dissection of the mass by the forces of erosion. In general, the more basic phases are disposed peripherally with respect to the more acid, which constitute the main mass of the Mountain, an arrangement comparable with that of the similar rock-types at Yogo Peak, in the Little Belt Mountains of Montana.

Detailed field, petrological and chemical investigation of this igneous complex is being carried out by the writer, and it is hoped that the results will be published later.

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FISHES FROM ONGTONG JAVA, MELANESIA.

By Gilbert P. Whitley, Ichthyologist, Australian Museum, Sydney.
(*By permission of the Trustees of the Australian Museum.*)

(Plate iii.)

[Read 24th April, 1929.]

Some time ago, I asked Mr. H. Ian Hogbin, who was leaving Sydney to study the anthropology of Ongtong Java, if he would make a collection of fishes there for the Australian Museum. My request was complied with and thanks are due to Mr. Hogbin for the well preserved series obtained. The fishes were all caught in the lagoon of the atoll of Ongtong Java and belong to East Indian or Indo-Australian species and show a marked similarity in facies to those of the Santa Cruz Archipelago. All the species, excepting *Pseudupeneus filamentosus* (Macleay), are fairly well known, so I merely list their names here, but give a detailed description and a figure of Macleay's species.

Ongtong Java is situated approximately in Lat. 5° S. and Long. 159° E., in Lord Howe's Group; this should not be confused with any other islands in the Pacific named after Lord Howe.

Native names of the fishes were supplied by Mr. Hogbin and indicate that the inhabitants of Ongtong Java recognize superficially similar species by giving them distinct appellations.

I have been unable to discover any previous account of the fish-fauna of Ongtong Java, though the occurrence of the Oil Fish or Palu (*Ruvettus*) in that region has been deduced by Gudger (*American Naturalist*, lxii, 1928, p. 476), who states: "From Tasman and Ontong Java (Lord Howe Islands) comes a wealth of hooks—eleven in the Field Museum alone (most of which I studied)—and in addition figures and descriptions from Parkinson, Thilenius, and Woodford, all of whom testify that the hooks were used only for taking the purgative fish—a favorite sport in these islands. All these hooks are huge ones, and Woodford states that these western Ruvettuses are from six to nine feet in length."

Mr. Hogbin has provided me with the words of one of the Ongtong Javanese prayers for fish. This was made once every year by the senior priest to the goddess Ke luahinge. It asked her to send (*a*) rough seas, because the drift logs used for canoes were washed up in storms, (*b*) pumice, used in making shell adzes from *Tridacna gigas*; pumice was also washed up in storms, and (*c*) various fish.

The following is the prayer and its translation. The italicized words in the latter refer to species of fishes, of which Mr. Hogbin notes that *save* means flying fish and *aku*, bonito. In the list (*infra*), *ngangue* is seen to be the Drummer, *Kyphosus*, but *alo* and *lupo* remain unidentified.

"'AHINGE, MANGAU KAI-HO HENGO
KAI-KEKE, KAI PUPU;
HUKIAMAI MANGAU KAI-HUANGA,
KO LA'AU, KO 'ALO, KO LUPO,
KO NGANGUE, KO SAVE,
MANGAU KO HE AKU.
MALAMA NGA HALE MOANGA,
NGA HALE ULIULI,
ALUALUMIA, MAI VAVE."

"KE LUAHINGE, send for me high tides,
rough seas, tumbling seas;
bring for me pumice,
your trees, your *alo*, your *lupo*,
your *ngangue*, your *save*,
for me your *aku*.
From the light of the houses of the ocean,
from the houses of darkness,
Bring them, bring them quickly."

Systematic list of fishes collected.

	Native name.
Stolephorus delicatulus (Bennett 1832)	sala
Æoliscus strigatus (Günther 1861)	kakau
Hemiramphus dussumieri Cuvier and Valenciennes 1847	polumea
Caranx forsteri Cuvier and Valenciennes 1833	'ipa
Elagatis bipinnulatus (Quoy and Gaimard 1825)	amai
Scomberoides sanctipetri (Cuvier and Valenciennes 1832)	lai
Epinephelus merra Bloch 1793	ngakala
Kuhlia taeniura (Cuvier and Valenciennes 1829)	kivikau
Lutjanus semicinctus Quoy and Gaimard 1824	kapulei
Lutjanus marginatus (Cuvier and Valenciennes 1828)	kaea
Lutjanus fulviflamma (Bonnaterre 1788)	kaimea
Rastrelliger chrysozonus (Rüppell 1836)	nga
Gerres argyreus (Bloch and Schneider 1801)	maku
Chaetodon (*Linophora*) *setifer* Bloch 1795	pipikau
Kyphosus cinerascens (Bonnaterre 1788)	ngangue
Mulloides samoensis Günther 1873	veke
Pseudupeneus (*Hogbinia*) *filamentosus* (Macleay 1883)	saokoro
Oceanops latovittatus (Lacépède 1802)	'olisi
Glyphisodon bengalensis (Bloch 1787)	mokumoku
Cheilinus fasciatus (Bloch 1791)	papu
Thalassoma (*Chlorichthys*) *purpureum* (Gmelin 1789)	kokolo
Thalassoma (*Chlorichthys*) *trilobatum* (Lacépède 1802)	alali
Teuthis (*Rhombotides*) *troughtoni* Whitley 1928	mangi
Callicanthus lituratus (Bloch and Schneider 1801)	umalei
Balistapus aculeatus (Linnaeus 1758)	simukai
Balistapus rectangulus (Bloch and Schneider 1801)	simukua

Family **Mullidae.**

Genus PSEUDUPENEUS Bleeker.

Pseudupeneus Bleeker, *Versl. Akad. Amsterdam*, xiv, 1862, p. 134. Genotype, *P. prayensis* Bleeker (*fide* Jordan, *Stanford Univ. Publ.*, Biol. Ser., Genera Fish., iii, 1919, p. 310).

HOGBINIA, new subgenus.

Head somewhat pointed; snout long; maxillary not nearly reaching to below eye; scales extending forward on top of head to level of nostrils. A single row of spaced, stout teeth in each jaw; vomer and palatines without teeth. Third and fourth dorsal spines elongate.

This subgenus is named in honour of Mr. Herbert Ian Hogbin who made the collection of Ongtong Java fishes which is reported upon in this paper.

Orthotype of subgenus, *Upeneus filamentosus* Macleay.

PSEUDUPENEUS (HOGBINIA) FILAMENTOSUS (Macleay). (Plate iii.)

Upeneus filamentosus Macleay, PROC. LINN. SOC. N. S. WALES, viii, 2, July 17, 1883, p. 264. Hood Bay, New Guinea. Type in Australian Museum, Sydney.—*Hypeneus filamentosus* Boulenger and Grant, *Zool. Record*, 1883 (1884), Pisces, p. 20.—*Pseudupeneus filamentosus* Jordan and Seale, *Bull. U.S. Fisher. Bureau*, xxv, 1906, p. 276; Ogilby, *Proc. Roy. Soc. Qld.*, xxi, 1908, p. 21 (name only).

Original description.—"D.8/9. A.7. L.lat.28. L.tr. 2/5. Height of body one-fourth of the total length; length of head greater than the height of the body, profile straight, space between the eyes a little convex, and as wide as two diameters of the orbit. Snout long and rather pointed, the distance from the eye to the snout being equal to four diameters of the orbit; the mouth is small; the lips thick; teeth strong and blunt. The spinous dorsal terminates in filaments, the third spine equals the height of the body. Colour pink, with yellow and blue lines about head and soft dorsal. Length, 9 inches. Mara-aga of the natives. Hood Bay."

Re-description of Macleay's type.—D.viii/9; A.i/6; P.i/16; V.i/5; C.15. L.lat.29. L.tr. $2\frac{1}{2}/1/5\frac{1}{2}$.

Head (101 mm.) 3 in length to end of middle caudal rays (303). Depth (86) 3·5; depth of caudal peduncle (41) 7·4 in same. Eye (11) 9·1, interorbital (20) 5·0, snout (52) 1·9, barbel (57) 1·7, maxillary (27) 3·7, and third dorsal spine (77) 1·3, in the head.

Head longer than high; profile oblique, gently rounded. Snout long. Maxillary not nearly reaching vertical of eye. A single row of small, strong, spaced, blunt teeth in each jaw; no teeth on vomer or palatines. Upper jaw slightly the longer. Nostril small, nearer mouth than eye. Eye small, interorbital convex. Barbels with filiform extremities, reaching slightly beyond vertical of preopercular margin. Opercular edges entire; a small spine on operculum. Seven plus eighteen short, slender gill-rakers on first gill-arch; the longest is less than half the diameter of the eye. Cheek-scales in three rows.

Body moderately elongate and compressed, covered with large, weakly ctenoid scales. Lateral line tubes arborescent. First dorsal rising behind origin of pectorals and ventrals, its first spine minute but the third and fourth very long. Base of spinous dorsal subequal to interdorsal space. Soft dorsal slightly in advance of anal, its anterior rays longest and closest together. Anal similar to soft dorsal, equal to it in height, but with the last ray produced. Both dorsal and anal terminate well before the caudal. Pectorals rounded, shorter than the ventrals, which are somewhat pointed. Caudal forked, the outer rays very strong.

Colour, after long preservation in formalin, and later spirit, brown.

Described from the lectotype of *Upeneus filamentosus* Macleay from Hood Bay, New Guinea, a damaged specimen, a little more than 13 inches long, in the Australian Museum, Sydney. Registered No. I.13403.

In Macleay's original description, the length of the fish is given as 9 inches, but as no specimen of that length can now be found and as the larger one I have described is evidently one of the typical series, I designate it the lectotype. It bears a wooden label upon which is written in Macleay's handwriting: "Upeneus filamentosus."

Variation.—Besides the type, the Australian Museum has three other spirit specimens of *Pseudupeneus* (*Hogbinia*) *filamentosus*, but these show minor variations. They are better preserved than the type, however, and in each the head is scaly dorsally as far as the nostrils, though the scales are rudimentary, and the area between the eye and the snout is naked. There are two small scales between the nostrils, and four rows of scales on the cheeks. Maxillary naked, or with one or two scales. Barbels not quite extending to preopercular margin, or reaching a trifle beyond same. Pseudobranchiae well developed. Last dorsal ray sometimes somewhat produced. A rudimentary anterior anal spine in one specimen.

The colour appears to have been fairly uniform pinkish or light beetroot with greyish margins to the scales and an orange tinge on the fins. Belly whitish. The anterior dorsal spines and rays and the upper and lower caudal rays are slightly smoky, and in one specimen there is a faint smoky blotch on each side of the caudal peduncle and a small mark at the origin of the lateral line. About four oblique, olivaceous bars on soft dorsal membranes. None of the specimens shows any lines or bars on the head. The largest specimen is sixteen inches long.

D.viii/8-9; A.i-ii/6; L.lat.29-30; L.tr.2½/1/5½-6½.

Figured specimen.—The specimen chosen for illustration is from Ongtong Java. It is better preserved than Macleay's type and only differs from it in having the dorsal fins slightly closer together, in showing a slight prolongation of the posterior part of the last dorsal ray, and in retaining some of its original colours.

Native names.—Mara-aga (New Guinea, *fide* Macleay); saokoro (Ongtong Java, *fide* Hogbin).

Localities.—Hood Bay, New Guinea. Lectotype of *Upeneus filamentosus* Macleay, presented by the Committee of Management of the Macleay Museum, University of Sydney, to the Australian Museum in 1914. Austr. Mus. regd. No. I.13405.

South-east New Guinea; purchased from J. Cairn in 1886. Nos. I.267-268.

Ongtong Java, Melanesia; collected 6th September, 1928, by H. Ian Hogbin. No. IA.3694.

Range.—New Guinea to Ongtong Java.

Generic affinities and taxonomy.—The generic name *Upeneus*, originally employed for this species by Macleay, is generally credited to Cuvier, but reference to the first definition (Cuvier, *Regn. Anim.*, ed. 2, ii, April, 1829, p. 157) shows that the name was only proposed as a vernacular, subservient to *Mullus* Linnaeus. It was used in a latinized form contemporaneously by Cuvier and Valenciennes (*Hist. Nat. Poiss.*, iii, April, 1829, 421 and 448; vii, April, 1831, 520) who, therefore, should be quoted as authors of the name. These workers divided *Upeneus* into several "little tribes" based on the dental characters, and these are nowadays differentiated into genera, thus: 1. *Upeneoides* Bleeker, 2. *Upeneichthys* Bleeker, 3. *Mulloides* Bleeker, and 4. *Upeneus* Cuvier and Valenciennes, *sensu lato*, including *Parupeneus* Bleeker and *Pseudupeneus* Bleeker. *Upeneus filamentosus* Macleay enters the fourth tribe, "*Upénéus des Indes à dents distinctes et sur une seule rangée (ils n'en ont point au palais)*", which embraces many species, and requires further subdivision. A later use of *Upeneus* was made by Voigt (Das Thierreich (Cuvier), ii, 1832, 218) who evidently regarded *U. vlamingii* C. and V. as the

most important species but did not formally designate it as type. The first designation of a logotype for *Upeneus* seems to have been made by Bleeker (*fide* Jordan, *Stanford Univ. Publ.*, Biol. Ser., Genera Fish., i, 1917, 127. See also Snyder, *Proc. U.S. Nat. Mus.*, xxxii, 1907, 88, footnote *ex* Jordan MS.) who chose *Mullus bifasciatus* Lacépède. Lack of literature unfortunately prevents me from investigating this matter fully; I do not know where Bleeker nominated this species, but quote on the authority of Jordan's "Genera of Fishes". If, however, *Mullus bifasciatus* be the type of *Upeneus*, *Parupeneus* Bleeker (*Nat. Tijdschr. Dierk.*, i, 1863, 342) becomes an absolute synonym of *Upeneus*. Bleeker later (*Versl. Akad. Amsterdam*, (2), ii, 1868, 344) named *Upeneus vittatus* the type of *Upeneus* but this selection is apparently invalidated by his earlier designation. Bleeker and Pollen (Poiss. Pêches Madagasc. in Pollen and van Dam, *Rech. Faun. Madagascar*, iii, 1875, 40, Pl. xviii, fig. 2) have given a good figure of "*Parupeneus bifasciatus*", the apparent genotype of *Upeneus*, from which *U. filamentosus* differs in its much longer snout, fewer preorbital pores, and more pointed head, external characters which probably overlie skull differences.

I have not been able to consult the original definition of *Pseudupeneus* Bleeker, which *Upeneus filamentosus* seems to approach. I may mention here, however, that *Pseudupeneus preorbitalis* (Smith and Swain) from Hawaii has smaller scales than those of most of the nominal species of the genus and is probably not congeneric. Ogilby (*Proc. Roy. Soc. Q'land*, xxi, 1908, 21) has given as species of *Pseudupeneus*, *P. barberinus* (Lacépède), *rubroniger* De Vis, *jeffi* Ogilby, and *porosus* C. and V. Though *P. barberinus* is close to *P. filamentosus*, the others do not appear to me to be congeneric. *Upeneus rubroniger* De Vis is a short-snouted form. *P. jeffi* Ogilby is nearer *Upeneoides tragula* Richardson. *Upeneus porosus* C. and V. is the type of *Upeneichthys* Bleeker. I may also note here that Ogilby elsewhere (Edib. Fish. and Crust. N. S. Wales, 1893, 33) used *Hypeneoides* for *Upeneoides* and *Hypeneichthys* for *Upeneichthys*, but these classical emendations, which have been generally overlooked, are purely synonyms.

EXPLANATION OF PLATE III.

Pseudupeneus (*Hogbinia*) *filamentosus* (Macleay). A specimen from Ongtong Java, Melanesia. × ½. Gilbert P. Whitley *del.*

A PRELIMINARY ACCOUNT OF THE ORIGIN OF TWO NEW AUSTRALIAN PHYSIOLOGIC FORMS OF *PUCCINIA GRAMINIS TRITICI.*

By W. L. Waterhouse, The University of Sydney.

(Plate iv.)

[Read 24th April, 1929.]

Introduction.

The occurrence of physiologic forms within well-defined morphological species of fungi has long been known and is widespread throughout the group.

Physiologic specialization in *Puccinia graminis tritici* E. & H., the fungus which causes stem rust in wheat, has received particular attention. Extensive studies, mainly carried out in North America, have revealed in it an extreme state of specialization. The most recent statement issued by Stakman and Levine (1928) sets out fifty-five physiologic forms which have been identified.

This extreme specialization of the pathogen seriously hinders efforts made to combat rust attack by the breeding of resistant varieties of wheat. There are instances in which certain varieties have been produced which were resistant to the forms of rust known to be present in that locality. But with the passage of time, these varieties have become liable to attack. Investigation has shown that this is due to the advent of new physiologic forms. It thus becomes a matter of importance to know how physiologic forms originate.

The writer is indebted to Dr. E. C. Stakman and Dr. M. N. Levine of the University of Minnesota for supplying grain of the differential hosts used in the investigation, to Mr. G. Wright of the University of Sydney for the loan of photographic apparatus, and to Messrs. G. S. Gordon, T. H. Harrison, W. H. Darragh and R. E. Dwyer for collecting and forwarding material, and gratefully acknowledges the help given.

Hypotheses advanced to account for Specialization.

Several suggestions have been made to explain the origin of specialization in this fungus.

1. *Nuclear interchange in uredo mycelia.*

In the uredospore stage, it is known that multiple infection of a wheat plant frequently takes place. Numerous cases have occurred in the writer's investigations in which two quite distinct physiologic forms have been identified from the one plant. Levine (1928) records the occurrence of three forms on the one collection of material.

It has been suggested that in a plant infected by two forms of rust, commingling of the two mycelia may take place. In the anastomoses, a nuclear interchange is possible between hyphae belonging to the two forms. This would lead to the production of a hypha and later a mycelium having a hybrid origin. Uredospores from this might be expected to exhibit physiologic capabilities different from those of its components, to be, in fact, a new physiologic form.

In the investigations which are in progress, some time has been spent in testing this hypothesis, but with negative results.

2. *Nuclear fusions in aecidial stage.*

A more attractive hypothesis has been put forward dealing with the aecidial stage of the fungus. The uredospore stage is binucleate. It gives place to the

teleutospore stage. The teleutospore cells are uninucleate, as are also the sporidia they produce. These sporidia infect young growth of the barberry, in which they give rise to a uninucleate mycelium. The binucleate condition is restored at the base of the aecidia. Here a cellular fusion of adjoining uninucleate hyphae takes place and leads to the production of binucleate aecidiospores. These produce the binucleate mycelium of the uredospore stage in wheat.

The suggestion is that the barberry may be infected at the same spot by sporidia of two diverse physiologic forms. Two genetically different mycelia may thus be present in the young barberry growth, and may commingle. At the base of an aecidium, the migrating nucleus of one form may become associated in the newly-created binucleate hypha with a nucleus of the second form. This would give rise to aecidiospores of mixed or hybrid ancestry, and these might be expected to show new physiological capabilities.

Repeated efforts have been made in past years to have viable teleutospores of several well established forms available at the same time for a series of such tests, but without success until this season. The possibility that such nuclear fusions may explain the cases herein recorded is discussed later in the paper.

3. *Mutations.*

Mutation has been put forward to explain the origin of specialization. To date no case has been recorded. Mutations are known in regard to colour of the uredospore. Newton and Johnson (1927) describe such a case, and in the writer's studies one similar case has occurred.

Despite the suggestions which have been put forward, the position has been obscure in regard to the origin of specialization.

Method of Determining Physiologic Forms.

In order to make clear the happenings herein described, it is well to indicate the method of determining physiologic forms of wheat stem rust. The procedure followed has been developed by Stakman and Levine (1922), also Levine (1928), and is briefly as follows. Twelve standard varieties of wheat have been selected as a result of much careful work. They are shown in the following table.

Table 1. The set of differential hosts selected by Stakman and Levine for the determination of physiologic forms of *Puccinia graminis tritici* E. & H.

Species of *Triticum*.	Varietal Name.	Cereal Investigation Number.
T. compactum	Little Club	C.I. 4066
T. vulgare	Marquis	C.I. 3641
,,	Kanred	C.I. 5146
,,	Kota	C.I. 5878
T. durum	Arnautka	C.I. 4072
,,	Mindum	C.I. 5296
,,	Arnautka (Spelmars)	C.I. 6236
,,	Kubanka	C.I. 2094
,,	Acme	C.I. 5284
T. monococcum	Einkorn	C.I. 2433
T. dicoccum	Vernal Emmer	C.I. 3686
,,	Khapli	C.I. 4013

Grain of these standard differential hosts was kindly supplied in 1921 by Dr. E. C. Stakman and Dr. M. N. Levine, and has since been grown in pure lines for use in the determinative work.

Seedlings to the number of about fifteen are grown in small pots. The first seedling leaf is moistened with water by means of a flat sterile needle, and the uredospores of the rust under examination are placed in this water adherent to the leaf. The pots are then incubated in a saturated atmosphere for 48 hours. They are afterwards placed on well-lighted benches in the plant house to allow the rust to develop. Notes are taken on the rust development twelve to sixteen days later, depending upon the prevailing weather conditions.

The types of infection shown by each host are recorded by a simple notation. Arabic numerals from 0 to 4 indicate the order of severity of infection. 0 indicates immunity, and 4 complete susceptibility. Fluctuations within these types are indicated by plus and minus signs. A sixth type is represented by ×. This indicates that a heterogeneous reaction occurs on the one plant. A single leaf may show all classes of reaction ranging from 1 to 4, and further simplification of these reactions is impossible.

The explanation of these symbols is set out hereunder.

Resistant Class.

Type 0.—Host immune.

No uredosori are developed, but sharply defined hypersensitive flecks may be present, indicated then as "0;".

Type 1.—Host very resistant.

Infection is very light; uredosori are minute and scattered, and surrounded by sharp, continuous, necrotic areas.

Type 2.—Host moderately resistant.

Infection is light; uredosori are small to medium in size. Hypersensitive areas in the form of necrotic halos are present. The pustules occur in green, but slightly chlorotic islands.

Susceptible Class.

Type 3.—Host relatively susceptible.

Infection is moderate; uredosori are medium in size and show a tendency to coalesce. True hypersensitiveness is absent excepting when cultural conditions are unfavourable.

Type 4.—Host completely susceptible.

Infection is normal and heavy. Uredosori are large and generally confluent. Hypersensitiveness is absent excepting when cultural conditions are unfavourable.

Indeterminate Class.

Type ×.—Host intermediately susceptible.

Infection is of a heterogeneous nature. Uredosori are very variable and apparently include all types and degrees of infection on the one leaf; no mechanical separation is possible since spores from small and from large uredosori alike produce the same heterogeneous infection.

When the class of reaction on the standard differential hosts has been determined, the results are tabulated. From these tabulated results a dichotomous key has been prepared, and by using this it is easy to determine the physiologic form of the rust under examination. A reference to Table 2 will show four of the forms set out in the conventional way.

Experimental Material and Methods.

In the investigations at the University of Sydney, the problem of how physiologic forms originate has long been under consideration. Numerous tests have been made, but not until the season which has just closed has a positive result been obtained.

It has several times been found in studies dealing with the aecidial stage that inoculation of young growths of the barberry with viable teleutospores has led to the production of spermagonia only. Craigie (1927) has recently published results of outstanding importance which throw much light on this occurrence. He has shown that *Puccinia graminis* Pers. is heterothallic. Further, the spermatia are not functionless male gametes as was formerly supposed, but are + and − haploid spores, which, by mingling, give rise to the diploid phase and lead to the development of aecidia. This work has led to attention being concentrated on the spermagonial stage in the life history.

During the summer of 1927-1928, numerous identifications of physiologic forms were made from uredospore material collected at widely separated localities in Australia. From certain of the collections, teleutospore material was also obtained. Three only of these need be considered.

1. *Werribee Material.*

One collection came from the State Research Farm, Werribee, Victoria. In November, 1927, a comprehensive series of samples of the rusted wheat crop was forwarded by Mr. G. S. Gordon, Cerealist. Investigation showed that the form present was Form 34. In July and August, 1928, two further batches of rusted wheat straw from the same area were submitted by Mr. Gordon. This material comprised stubble which had been cut at harvest and which showed abundant teleutosori, together with "second growth" shoots of wheat carrying abundant uredo- and teleuto-sori. The unusually copious autumn rains had been responsible for the development of this "second growth" and for its heavy rust infection. From both batches, uredospores were at once used to infect the standard set of differential hosts. The form present was Form 34. The straw was then placed in light wire frames to keep it intact, and exposed on the ground to the weather conditions prevailing at the University.

It is of interest to record that a further series of determinations made during the summer of 1928-1929—i.e., following upon the barberry work described herein—has shown the presence of only Form 34 at Werribee.

Early in September, 1928, germination tests proved that the teleutospores were viable. Later a young plant of *Berberis vulgaris* growing in a pot was inoculated with fragments of the straw carrying the teleutosori. The method used was to atomize the plant with sterile water. A certain amount of this remained on the young shoots. These were very gently rubbed with the fingers cleansed in alcohol and washed in running water. The rubbing was found to aid greatly in wetting the cuticle. On the wet shoots were placed wetted fragments of straw carrying teleutosori. The plant was incubated in this condition for 48 hours in an inoculation chamber containing a saturated atmosphere. Afterwards the pot was placed on the plant-house bench and watered when necessary.

After twelve days there were abundant spermagonia on some of the inoculated shoots. Aecidia developed in some cases, but other infections gave rise only to spermagonia. Over these were smeared spermatia from the Grafton rust, to be described presently as the third culture. In the same way, spermatia from the

Werribee rust were smeared over the spermagonia on the barberry infected by the Grafton rust. The operation was carried out with the aid of a fine camel-hair brush sterilized in alcohol and then in distilled water. One of the infected petioles is illustrated in Figure 2 of Plate iv.

After about six days aecidia were developed on the shoots where mixing of spermatia had been carried out. Aecidiospores were used to inoculate seedlings of "Federation" wheat growing in pots. Two methods were used. In the first, the spores were collected on a small sterile camel-hair brush moistened with distilled water and lightly brushed over the aecidia. From the tip of the brush the aecidiospores were transferred to the moistened leaves of the "Federation" seedlings. In the second case, the aecidiospores were shaken from the shoot into a sterile petri dish and then transferred to the moistened wheat seedling leaves. In each case the pots of inoculated seedlings were incubated in a saturated atmosphere for 48 hours and then placed in isolated positions on the plant-house benches. The aecidiospores from the normally-produced aecidia were not kept separate from those borne in aecidia resulting from the spermatial intermixing.

Four cultures were thus obtained with intervals of three to four days between each. The aecidiospores were not nearly as abundant as in the case of the Bathurst rust, with the result that the uredosori produced on the "Federation" seedlings were scanty. All four cultures had, therefore, to be transferred from "Federation" to new pots of "Federation" seedlings in order to obtain a quantity of inoculum sufficient to inoculate the regular differential hosts.

Three out of the four cultures gave an identical result. The form present was not Form 34. It was the form which has been identified by Stakman and Levine (1922) as Form 11. It differs from Form 34 in the reaction shown by Einkorn. This host is susceptible to Form 11 but resistant to Form 34. The contrast in the reactions is as sharp as possible. This is illustrated in Fig. 3 of Plate iv.

This unexpected result was checked in many ways. Inoculum from each of the ten susceptible varieties of the standard differential hosts was used to inoculate further sets of differentials. So far thirty-six of these tests have been made. In all cases the result has been the same. The form is Form 11.

It was a coincidence that on the day the first of these inoculations of the differential set was made, a similar set was inoculated with a new uredospore culture which had just come to hand from Werribee. This gave Form 34. A mixing of seed or mistake in labelling was clearly not responsible for the unexpected identification of Form 11.

The fourth culture of "Federation" seedlings derived from the aecidiospores gave a different result. The form present proved to be Form 34. In this case the sojourn on the barberry had exerted no influence upon the form.

It is unfortunate that a differentiation was not made between the shoots which produced spermagonia and aecidia without outside interference, and those which produced aecidia only as a result of admixture of spermatia with those of the Grafton rust. But both things happened, and it is believed that this is the explanation of Forms 11 and 34 appearing from these cultures.

2. *Bathurst Material.*

An extensive series of collections was made at the Bathurst Experiment Farm by Mr. R. E. Dwyer, B.Sc.Agr. From this area, rusted straw was obtained

at intervals of approximately a fortnight, commencing in November, 1927, and ending late in April, 1928. Thereafter it was obtained at monthly intervals until July, 1928, when nc uredosori were found and only the teleutospore stage of the rust was present on the straw. This straw was allowed to remain out in the open at Bathurst, exposed to the winter conditions which prevailed there, and was used in the spring for the barberry inoculations.

This series of determinations of the uredospore stage involved sixteen distinct tests on the standard set of differential hosts. The first, made in November, 1927, showed that a mixture of Forms 34 and 43 was present. Thereafter no sign of Form 43 was found. Form 34 alone was identified. The collections were bulky and random samples from them were used in the determinations, so that it is unlikely that Form 43 was present and not detected. It may further be remarked that a later series of identifications made during the 1928-1929 season has shown only Form 34 at Bathurst.

Early in September, 1928, some of the teleutospore material was sent from Bathurst to the University and was found to be in a viable condition. The straw was used to inoculate a young barberry plant growing in a pot. This inoculation led to the production of a few spermagonia only.

In October, a further supply of the rusted straw was obtained from Bathurst and used for further barberry inoculations. Spermagonia were very abundant in nine days, and four days later numerous aecidia were present on many of the young growths. On certain shoots the infection was very heavy and aecidiospore production was abundant. An illustration of this is given in Figure 1 of Plate iv. On other shoots aecidial production was very scanty, and on a few leaves only a few spermagonia were found. Spermatia from these last-named were mixed with those on the barberry which was infected by the Grafton rust, and spermatia of this Grafton rust were in turn mixed with those on the plant under consideration.

At short intervals commencing early in November, seedlings of "Federation" wheat in pots were inoculated with aecidiospores. Both methods of transference already described were used. The result was that four pots of seedlings producing abundant uredosori were obtained at intervals of about four days. The uredospores were used for inoculating the standard set of wheat differentials in order to determine the physiologic form. Three out of the four pots gave the normal reactions for Form 34. That is to say, the completing of the life cycle on the barberry had not affected the parasitic capabilities of the rust as determined by the standard test. In the case of the fourth culture, there was a departure from the normal reaction shown by Form 34. The pot of Einkorn, instead of giving the characteristic flecking of the resistant reaction, showed eleven of the thirteen plants with this normal reaction, whilst the remaining two seedlings showed this reaction intermixed with pustules of the "3" type belonging to the susceptible class. Uredospores from these pustules were transferred to a pot of "Federation" and a pot of Einkorn, producing on each the normal susceptible reactions. This culture was used to inoculate the standard set of differentials. It proved to be Form 11, the form which also occurred in the aecidial cultures obtained from the Werribee rust.

3. *Grafton Material.*

A third collection of material was made at the Grafton Experiment Farm by Mr. W. H. Darragh, B.Sc.Agr. During the months of November and December,

1927, six different comprehensive sets of uredospore material were obtained from numerous wheat varieties. On some of the straw, teleutosori were also abundant. Tests with five of the batches showed the presence of only Form 34. In the sixth, two forms were present. One was Form 34, the other Form 43.

Again, it is of interest to know that a further series of tests made later with uredospore material collected in October, November and December, 1928, has shown only Form 34 to be present.

In January, 1928, Mr. Darragh forwarded a collection of wheat stubble showing heavy teleutospore infection. This, together with the straw infected by the uredo- and teleutospore stages which had been used in the form determinations, was placed in a light wire frame and exposed at the Hawkesbury Agricultural College to the prevailing winter conditions. At intervals a few straws were withdrawn from the frame by Mr. T. H. Harrison, B.Sc.Agr., and submitted for teleutospore germination tests. Early in September, 1928, the teleutospores proved to be viable. Later a barberry plant was inoculated with fragments of the straw, of which only a small amount was then available. Within twelve days, two of the shoots produced spermagonia. These were kept under observation for aecidial production, but none developed. Spermatia from them were taken for admixture with the Bathurst and Werribee rusts, and spermatia from these latter were in turn mixed with those produced by the Grafton rust. In eight days there were a few aecidia on the under surfaces of the two leaves bearing the spermagonia. The latter persisted for an unusually long period.

Aecidiospore production was necessarily scanty, and a number of attempts were made to obtain the uredospore stage on "Federation" seedlings. An inoculation made at the end of October gave one infected seedling. This inoculum was used to infect a fresh pot of "Federation" seedlings. From these, the standard set of differentials was inoculated in order to determine what form was present. It proved to be a form which has so far not been recorded. It resembles Form 18, but differs markedly in its reaction on Einkorn. Instead of giving on this host the susceptible "3" type of reaction which is characteristic of Form 18, the new form gives the sharp flecks of the strongly resistant reaction. These results have been repeatedly checked by numerous cross-inoculations of the standard set of differential hosts. To date, twenty of these tests have been made. In Figure 4 of Plate iv is illustrated the flecking of a leaf of "Mindum" by this form, in comparison with the susceptible reaction on the same host given by Form 34. In colour the new form differs markedly from any other form that is available. Judged by the Ridgway (1912) colour standards, it is "Raw Sienna" of Plate iii, whilst the Forms 11 and 34 are "Sanford's Brown" of Plate ii, and Form 43 is "Burnt Sienna" of Plate ii.

Discussion.

Investigations with the uredospore stage of *Puccinia graminis tritici* E. & H. which have been in progress for a number of years, have revealed the presence in Australia of certain definite physiologic forms. Several hundred of these determinations have been made.

One of these forms is Form 34. Of late years this has been predominant and still more recently has been the only form found. It is one of the very virulent forms and has been recorded by Stakman and Levine from several continents.

Another form which used to be found very frequently is Form 43. Since December, 1927, this has not been found on the mainland of Australia, although one determination made in January, 1928, with material from Tasmania, revealed

its presence there. Form 43 has some characteristics which are unusual. One is its apparent inability to infect the barberry, although it produces viable teleutospores. So far it has not been found outside Australia.

Tests with the uredospore stage on wheat collected at Werribee, Bathurst and Grafton have shown that Form 43 was last found at the first-named station in 1925. The only Werribee rust found in 1927 and since then was Form 34; there has been no indication of the presence of any other form in that locality. At Bathurst, Form 43 occurred in November, 1927, intermixed with Form 34, but since then an extended search has revealed the presence of only this latter form. It is believed that the teleutospore material used from Werribee and Bathurst was Form 34. Part of the actual Grafton straw used in the teleutospore stage was shown in its uredospore stage to comprise Forms 34 and 43. These two forms may reasonably be considered to have been present in the teleutosori used to inoculate the barberry.

Previous work (Waterhouse, 1921) has shown that contrary to the old belief, stem rust of wheat in Australia has not lost its capacity to infect the barberry. In the 1927-1928 season, teleutospore material of Form 34 was on hand from many localities. The only available material known to have any other form present was the straw from Grafton comprising Forms 34 and 43. One of the reasons for using it was to extend further the attempts to produce the aecidial stage of Form 43. The straw carrying Form 34 was used partly in order to see whether the aecidial stage on the barberry differed in its physiologic capabilities. Although Craigie's work was known, the pressure of other duties at the time made it impossible to use monosporidial cultures on the barberry. By the time the results herein recorded were obtained, the teleutospores had lost viability and it was impossible to use this necessary refinement.

The fact remains that from the aecidia on the barberries, three distinct physiologic forms were obtained. One of these was Form 34 which was well known to have been present in the teleutospores used to produce the infections. Numerous tests have shown no difference between this aecidial culture and the stock uredospore cultures of Form 34, as judged by the reactions on the standard differentials. The other two forms which were obtained had never before been grown in culture, nor have they turned up since in the work that has been done. It is hardly possible that either of them could have been present and not detected in the teleutospore material that was used. Of the two, one is established as Form 11. The other is, as far as can be learned, new to Science and will have to be given its proper designation.

A comparison of the four forms which are herein referred to is instructive, and is set out in Table 2.

It will be seen that of the twelve differential hosts, the first two, viz., Little Club and Marquis, are susceptible throughout, and the last two, viz., Vernal Emmer and Khapli, are resistant throughout. The remaining eight differentials are therefore the ones to be considered.

The Forms 34 and 43 which were known to be present in the teleutospore stage are remarkably different. Form 34 is very virulent. Form 43 attacks but few of the differentials. Form 11, which is one of the two which have originated on the barberry, resembles Form 34, but is more virulent, since it attacks Einkorn. Susceptibility of Einkorn is one of the characteristics of Form 43. For this reason, in the large series of cross-inoculations that was made, an especial watch was kept on the results obtained when inoculum from Einkorn was used. Form 11

Table 2. Means of the reactions produced by certain physiologic forms of *Puccinia graminis tritici* E. & H. on differential varieties of *Triticum* spp.

Physiologic Forms.	Infection Means on											
	Lc. Little Club, C.I. 4066.	Ma. Marquis, C.I. 3641.	Krd. Kanred, C.I. 5146.	Ko. Kota, C.I. 5878.	Arn. Arnautka, C.I. 4072.	Mnd. Mindum, C.I. 5296.	SpM. Arnautka (Spelmars), C.I. 6236.	Kub. Kubanka, C.I. 2094.	Ac. Acme, C.I. 5284.	Enk. Einkorn, C.I. 2433.	Em. Vernal Emmer, C.I. 3686.	Kpl. Khapli, C.I. 4013.
11	4	4=	3++	3+	4=	4=	4=	3++	3++	3	1=	1=
34	4+	4−	4−	4=	4	4=	4=	4=	3++	1=	0;	1=
43	4	3++	0	0;	0;	0;	0;	×	1	3	1	0;
New form	4	3++	3++	3	0;	0;	0;	3	3	0;	0;	0;

was obtained in every instance. Parallel sets were inoculated with a standard culture of Form 34 to serve as checks. The susceptibility of Einkorn, which is characteristic of Form 43, has replaced its resistance, characteristic of Form 34, thus leading to the production of Form 11. The fact that no one of the aecidial cultures gave the reactions of Form 43 goes further to confirm the conclusion previously arrived at that Form 43 does not infect the barberry.

The advent of such a form as Form 11 may have serious consequences if it should become widespread in Australia. As a result of the studies that have been made, an American variety of wheat named "Hope"—obtained from Stakman and Levine—has been found to be resistant to all known forms of Australian rust. It has, therefore, been used rather extensively in the work of breeding resistant varieties suitable for Australian conditions. "Hope", as a commercial variety, is valueless for our wheat-growing conditions. Now that cultures of Form 11 have become available, "Hope" has been tested with it in the plant house. It proves to be susceptible. Thus, in order to combat attack by this form, it becomes necessary to search for a variety of wheat which is resistant to it, and then make further crosses and carry out the necessary selection work.

The new form, whose true designation by Stakman and Levine is not yet available, resembles Form 34 excepting that the three durum wheats Arnautka, Mindum, and Arnautka C.I. 6236 (Spelmars), instead of being very susceptible, are markedly resistant. With all the Australian forms that have been found, these three differentials have been all susceptible or all resistant. Therefore in differentiating Australian forms, nothing has been gained by utilizing all three hosts. Their use has been continued, however, because of the possibility of forms turning up similar to other known forms which are separable by these three differentials. In the new form derived from the barberry, the resistance of these three hosts, which is a characteristic of Form 43, has taken the place of the susceptibility characteristic of Form 34.

The complete answer to the question as to how the two new Australian forms actually originated will not be given until further monosporous infections are obtained and cytological investigations carried out. It is significant that barberry infections caused by the Werribee and Bathurst rusts—both of them Form 34—produced aecidia and that some of the aecidial cultures from each were in turn Form 34, although others were Form 11. On the other hand, the Grafton rust comprising Forms 34 and 43 produced spermagonia only, until after the mixing of the spermatia. The aecidial culture then obtained proved to be no one of the known forms, but an altogether new form.

Craigie (1927) has shown that *Puccinia graminis* is heterothallic. Even so the abundant multiple infections produced on the barberries by the Werribee and Bathurst rusts would render easy the admixture of spermatia on the shoots, with consequent production of aecidia. Form 34 would be expected to turn up in the subsequent form determinations. In addition to these aecidia, other aecidia might be expected to result from the intermixing of the spermatia with those from the Grafton rust, and thus account for the origin of Form 11. It is of course just possible that another form was present in the teleutosori used, and that a cellular fusion of adjoining hyphae, which had a diverse origin, led to the production of Form 11, which had never before been found in Australia.

In the case of the barberry infected by the Grafton rust, Forms 34 and 43 were present in the inoculum. The infections produced were merely of a spermagonial nature up to the time of intermixture of spermatia. Only consequent upon this were produced the aecidia from which the new form was determined. It is this occurrence with the Grafton rust which most strongly supports the belief that spermatial intermixing gave rise to the new forms. If so, Craigie's discovery of the importance of the spermatia takes on an added significance. So far no effort has been made to trace cytological happenings following upon a mixing of spermatia. Investigations in this direction have been planned, but extreme difficulty is being met in the attempt to grow to maturity wheat plants infected with known forms of rust, because of the ravages of *Erysiphe graminis* D.C. Other studies involving the two new forms are in progress.

Craigie has called attention to the importance of insects in transferring spermatia and leading to aecidial production. If it be correct that such transference leads to the production of new physiologic forms, it would be expected that physiologic forms would be numerous where barberries occur, and fewer where they are scanty. In North America barberries are widespread, and physiologic forms are numerous. In Australia they are uncommon and physiologic forms are few.

Whether the spermatial intermixing be the prime cause of the origin of specialization, or whether it be due to hyphal fusions at the base of the aecidia, it seems certain that physiologic forms originate on the barberry. This gives the strongest possible reason why this alternate host should be eradicated.

Summary.

Wheat straw infected with the uredospore stage of *Puccinia graminis tritici* 34 and later with its teleutospore stage, was collected from Werribee, Vic., and from Bathurst, N.S.W., and similar material infected with a mixture of *P. graminis tritici* 34 and 43 from Grafton, N.S.W.

Successful barberry infections were obtained in the spring of 1928 by mass inoculation with teleutosori attached to the straw.

The Werribee and Bathurst rusts produced aecidia normally on some shoots, in addition to spermagonia. The Grafton rust gave rise to spermagonia only.

Spermatia from the Werribee and Bathurst rusts were respectively intermixed with those developed by the Grafton rust.

Consequent upon the spermatial intermixing, the Grafton rust developed aecidia, as did the other two.

Aecidiospores from the Werribee and Bathurst rusts developed uredospore cultures on wheat which proved to be mixtures of Forms 11 and 34.

Aecidiospores from the Grafton rust gave rise to a uredospore culture which is a new form as far as available records show.

Form 11 and the new form have never before been in culture, although hundreds of form determinations of Australian rusts have been made.

The two rusts which are new to Australia had their origin in the phase of the life history on the barberry.

It is believed that in this phase, the mixing of spermatia of Form 34 with those of Forms 34 and 43 led to the development of the two new rusts. Further work is planned to test this belief.

Insect transmission of spermatia under natural conditions with consequent production of new forms would account for the abundance of the latter in North America where barberries are widespread, and for their paucity in Australia where barberries are uncommon.

The strongest reason for eradicating barberries is afforded by this work.

EXPLANATION OF PLATE IV.

Fig. 1.—Young shoot of *Berberis vulgaris* showing heavy aecidial infection and distortion with rust from Bathurst. Natural size.

Fig. 2.—Petiole of *B. vulgaris* showing aecidial infection produced by rust from Werribee. × 3.

Fig. 3.—Two leaves of Einkorn wheat showing on the under-surface the resistant reaction and flecking produced by Form 34 in "*a*", and the susceptible reaction produced by Form 11 in "*b*". × 2.

Fig. 4.—Two leaves of Mindum wheat showing on the under-surface the resistant reaction and flecking produced by the new form in "*a*", and the susceptible reaction produced by Form 34 in "*b*". × 2.

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NOTES ON AUSTRALIAN DIPTERA. No. xix.

By J. R. Malloch.

(Eleven Text-figures.)

[Read 24th April, 1929.]

Family Mycetophilidae.

Recently in comparing notes with Mr. F. W. Edwards of the British Museum, who was on a visit to Washington, he drew my attention to the fact that he had some time previously subdivided the old genus *Platyura* Meigen in a paper dealing with the British Mycetophilidae (*Trans. Ent. Soc. London*, 1925, pp. 505-662).

I had not received a copy of his paper nor of the one dealing with New Zealand species in which he collaborated with Mr. A. L. Tonnoir, so was unaware of the course he had pursued in the matter. It was therefore of interest to discover that we had independently made use of nearly identical characters for generic segregations. I have not seen *Arctoneura* Hutton or *Nervicincta* Marshall, which genera Edwards removes to the subfamily Ditomyiinae. One change that is necessary is the suppression of *Calliplatyura* Malloch in favour of *Proceroplatus* Edwards, the concepts being identical. It may be that *Isoneuromyia* Brunetti is the same as my *Xenoplatyura*, but it will be necessary to examine the genotype of the former to determine whether it possesses the characters mentioned as of generic import in my description before coming to a decision. *Neoplatyura* Malloch does not appear to have been considered by Edwards.

Family Tachinidae.

This family is one of the most difficult problems in the order for the systematist. It appears to be one of the most recent, and, having specialized habits, practically all of the species being parasitic, the diversity of characters is astonishing. Here, as in other families, the older authors adopted very broad generic concepts, frequently placing many quite distinct groups within the same genus so that it is usually impossible to identify their species without an examination of their type specimens. Robineau-Desvoidy added many genera, but his definitions are in a great many cases too vague, and as practically all of his collection has been lost, it is largely guesswork to decide what his genera really are, provided no older species were included. Subsequent to Robineau-Desvoidy's time the most pretentious work on the family is that by Brauer and von Bergenstamm, and though this is without doubt the best illustrated work on the family, even up to the present time, it is a very difficult one to understand and to use. In addition to these works, which deal more extensively with generic concepts than any previously published, there have appeared many papers by van der Wulp, and more recently by Townsend, in which numerous genera have been proposed.

Of revisional or comprehensive works on the family the best and most recent are those by Coquillett, and Williston, on North American, and by Lundbeck, and Stein, on European, forms.

I have at present but few Australian Tachinidae available, and present below a few notes on some of these. My recently published catalogue will give some idea of the number of species already recorded from Australia, but to elucidate many of the species it will be necessary to resort to type examination or extensive collecting in the localities from which the types were obtained. In some of my previously published papers in this series will be found notes on genera other than those now dealt with, and should opportunity offer I may at some future time further extend my presentation of data on the family.

Most of the material now before me is the property of the Australian Museum, but some species were obtained on loan from the United States National Museum, and a few from other sources. In all cases the location of the material is mentioned in the paper, and where there are new species represented by specimens received from Australia direct by me the type specimen will be returned to the sender for deposition in some Australian Museum.

Tribe **Phasiini.**

This tribe is variously treated by different authorities on the family, some considering it a subfamily and others giving it full family rank, though I consider the proper status is as above. The members of it have a rather peculiar habit, being quite stout, with a broadly ovate abdomen which generally lacks well developed dorsal bristles, and the small knob immediately in front of the base of wing on the pleura stands farther out than the equally small sclerite immediately above it.

Of the recorded Australian genera only *Hyalomyia* Robineau-Desvoidy and *Gymnosoma* Meigen belong here, but probably other genera occur.

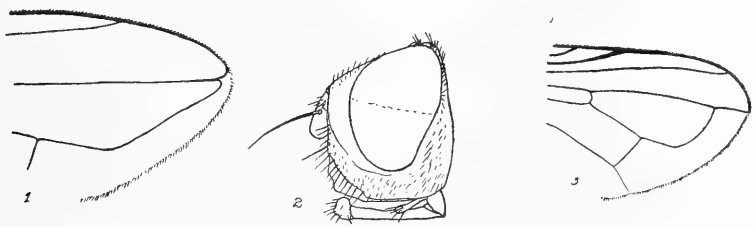
I have carefully examined the genotypes of nearly all of the genera placed in the tribe and am very decidedly of the opinion that there are altogether too many described genera which are distinguished by characters of little or no systematic value. The genus *Phasia* Latreille is one of the most readily distinguished of all, its genotype, *hemipterus* Fabricius, possessing long hairs on the central upper portion of the postalar declivity, and shorter hairs on the suprasquamal ridge and on a portion of the upper side near the outer margin of the upper calypter; the first posterior cell of the wing is closed at some distance from the margin of wing, but the apical section of fourth vein is much more oblique than in *Hyalomyia* and it is also more or less obviously undulated, which is not the case in that genus. The genera *Ectophasia* Townsend and *Xysta* Meigen have the first posterior cell of the wing open, but the former has numerous hairs laterad of the anterior fronto-orbital bristles and the facial ridges are furnished with long hairs on almost their entire extent, while *Xysta* has no hairs laterad of the fronto-orbital bristles, and the facial ridges are furnished with strong setulose hairs on only their lower portions and are bare from below level of apex of third antennal segment to upper margin. *Elomyia* Rondani is also a good genus, the principal distinguishing feature consisting of the unique character presented in the inward curvature of apex of costa and fourth vein (Text-fig. 1). I cannot see any reason why *Hyalomyia* Robineau-Desvoidy, *Austrophasia* Townsend, and *Phorantha* Rondani should be considered as distinct genera; in fact I would not consider them as entitled to subgeneric rank as Brauer did in 1893 (*Verh. Zool.-Bot. Ges.*, vol. 43, p. 497). Fine distinctions based upon wing venation are eminently unsatisfactory for the purpose of distinguishing genera, and Towns-

end's action in erecting *Austrophasia* on the basis of Macquart's figure of the wing of *Hyalomyia rufiventris* Macquart is indefensible.

Genus Hyalomyia Robineau-Desvoidy.

I have examined the type species of this genus, *pusilla* Meigen, and on the basis of that examination have arrived at the conclusion, already noted above, that there is no reason for the recognition of more than one valid genus in the group of species assigned to it, *Phorantha*, and *Austrophasia*. It is entirely possible that certain other workers would consider the three smaller species described below as entitled to generic separation from *nigrisquama* on the basis of the structure of the head, but I am of the opinion that in this family the variations of cephalic form have been given undue weight in generic segregation and consequently place all the Australian species now known to me in one genus.

So far as known the species referred to the genus as at present accepted by me are parasitic upon Hemiptera. I have before me an Indian species which, in one of its colour phases, agrees closely with the description of *Hyalomyia rufiventris* Macquart and this was reared from the red cotton bug (*Dysdercus* sp.). There is no indication of any rearing record on any of the Australian specimens.



Text-fig. 1.—Apex of wing of *Elomyia lateralis* Meigen.
Text-fig. 2.—Head of *Hyalomyia nigrisquama*, n. sp., from the side.
Text-fig. 3.—Apex of wing of *Hyalomyia nigrisquama*, n. sp.

In the material before me there are four species, three of them quite similar in most respects to *pusilla* Meigen, but differing in certain structural characters, while the fourth more nearly resembles the species usually placed in *Phorantha*, though there are but few hairs laterad of the inner series of bristles on the anterior portions of the frontal orbits. Below I present a key for the identification of the species, but do not include *rufiventris* which should be readily distinguished by the red abdomen, large size (7 mm.), and the pale squamae.

Key to the Species.

1. Large species, about 10 mm. in length; face projecting but little in profile (Text-fig. 2); scutellum with the apical pair of bristles well developed and situated at tip; extreme costal margin of wing, and the calyptrae, except the connecting margins, fuscous; venation of apical section of wing as Text-figure 3 .... *nigrisquama*, n. sp.
   Smaller species, not more than 5 mm. in length; face much projecting in profile (Text-fig. 6); apical pair of scutellar bristles very short and fine, situated before apex, almost on disc; wings and calyptrae pale 2
2. The hairs on upper anterior portion of mesopleura normal, not flattened; wings brownish hyaline, apical venation as Text-figure 4; abdomen about as broad as long, fourth visible tergite very little longer than third and about three times as broad at base as long in centre ..... *lativentris*, n. sp.

Most, or all, of the hairs on upper anterior portion of mesopleura flattened, lanceolate or scale-like; wings whitish or hyaline; abdomen much longer than broad, fourth tergite very distinctly longer than third 3

3. Hairs on upper half of mesopleura golden yellow and very noticeably flattened; hind femora with long yellowish bristly hairs on basal four-fifths, black haired at apices ..... *lepidofera*, n. sp.

Hairs on upper half of mesopleura mostly black, the yellow hairs confined to anterior portion and but slightly flattened; hind femora entirely black haired .... *nigrihirta*, n. sp.

N.B.—It must be noted that only males are included in the above key, and that the females do not have the peculiar flattened mesopleural hairs mentioned above.

Hyalomyia nigrisquama, n. sp.

Male.—Head black; orbits, face, cheeks, and occiput whitish grey dusted, antennae black, second segment slightly reddish at apex, palpi reddish-yellow; hairs on cheeks and on occiput, except the postocular ciliae, white, frontal hairs black. Thorax black, whitish dusted on dorsum, when seen from behind with four black vittae, the central pair fused behind suture, forming a broad black central postsutural area; scutellum slightly grey dusted; hairs on pleura largely pale. Abdomen shining black, with a brownish tint basally, and bronzy or greenish apically, possibly variable in the species, without trace of dusting; hairs on abdomen all black. Legs black. Wings hyaline, fuscous at base of costa to slightly beyond humeral cross-vein. Calyptrae fuscous, white at connecting portions, lower one brownish on disc.

Eyes bare; frons almost linear above, orbits with fine short hairs above, becoming longer and stronger along inner margins anteriorly, and with a few hairs laterad of the marginals; parafacials bare, each in profile about equal in width to third antennal segment (Text-fig. 2); cheek not twice as high as width of third antennal segment; arista short, bare; palpi small. Presutural thoracic bristle undifferentiated from the surrounding hairs which are numerous and erect, only the prescutellar dorsocentrals and acrostichals present and these very fine and short; scutellum with six marginal bristles, the apical pair at tip; some hairs below lower calypter on postnotum. Abdomen depressed, hardly longer than broad, dense piliferous punctures on entire dorsum; fifth sternite with a pair of short thumb-like processes which are separated at bases by a space less than their own length. Legs stout, fore tarsi a little widened. Apical wing venation as Text-fig. 3.

Length, 10 mm.

Type, French's Forest, N. Sydney, N.S.W., 14.xii.1923 (T. G. Campbell). Australian Museum.

Hyalomyia rufiventris Macquart differs from the above species in having the abdomen entirely red, and the calyptrae pale. It is also smaller, about 7 mm. in length, and the type specimen was from Tasmania. It was cited by Townsend as the genotype of a new genus, *Austrophasia*, without any basis except Macquart's figure of the wing.

Hyalomyia lativentris, n. sp.

Male.—Black, slightly shining, with dense pale grey dust on head, thorax, and abdomen. Antennae black; palpi yellowish at bases, fuscous at apices; hairs on cheeks and lower occiput white, the others black. Dorsum of thorax with four black vittae anteriorly, the median pair discontinued a little behind suture, the sublateral one on each side continued almost to hind margin; pleura grey

dusted, all the hairs fuscous; scutellum rather broadly grey dusted at apex. Abdomen when seen from behind densely whitish-grey dusted, disc of basal two tergites more or less black, when seen from above and one side the dorsum is almost entirely black, slightly shining and faintly violet or purplish tinged; hairs black. Legs entirely black, with black hairs. Wings very pale brown, or brownish hyaline, veins brown. Calyptrae yellowish-white. Halteres with yellow knob.

Eyes bare, facets on upper halves distinctly larger than those of lower halves; frons linear, each orbit with a single series of setulae along inner margin; head in profile as in *nigrihirta*. Presutural bristles and one pair of the presutural dorsocentral bristles in front of suture present but weak, prescutellar pair of dorsocentrals and acrostichals well developed, a short anterior second pair of dorsocentrals evident; scutellum short, lateral bristles long, apical pair not one-third as long as these and very fine; posterior sternopleural bristle long. Abdomen about as broad as long, almost circular in outline when seen from above, fourth visible tergite a little longer than third, its basal width about three times as great as its length in centre. Legs stout, without exceptional armature, hind tarsi not longer than hind tibia; tarsal claws and pulvilli long. Apical venation of wing as in Text-fig. 4; inner cross-vein a little more than one-third from apex of discal cell.

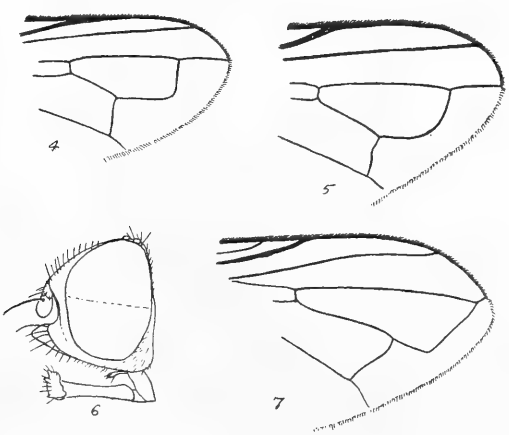
Length, 5 mm.

Type, Cairns, N. Queensland (J. F. Illingworth). United States National Museum.

The entirely black hind tarsi of this species give an additional character for distinguishing it from the following two.

HYALOMYIA LEPIDOFERA, n. sp.

Male.—Head black, interfrontalia black, orbits, face, cheeks, and occiput with dense pale grey dusting; antennae black; palpi fuscous; genal hairs pale. Thorax black, quite densely grey dusted, dorsum when seen from behind with a rather



Text-fig. 4.—Apex of wing of *Hyalomyia lativentris*, n. sp.
Text-fig. 5.—Apex of wing of *Hyalomyia lepidofera*, n. sp.
Text-fig. 6.—Head of *Hyalomyia nigrihirta*, n. sp., from the side.
Text-fig. 7.—Apex of wing of *Hyalomyia nigrihirta*, n. sp.

broad shining black vitta laterad of each dorsocentral line, the presutural submedian vittae faint or lacking, the dust on the area between the vittae behind suture brownish-yellow, not pale grey. Abdomen seen from behind with dense pale grey dusting, more yellowish on sides of dorsum of third and fourth visible tergites and rather changeable, with a dorsocentral vitta of variable width when seen from any angle, which is shining black with a purplish tinge; hairs black. Legs black, basal segment of fore and mid, and basal two segments of hind, tarsi testaceous; all femora yellow-haired basally, the hind pair most extensively so. Wings whitish hyaline, first and second veins yellowish, the others fuscous; a slight dark suffusion at apices of wings in type may not be normal. Calyptrae whitish. Halteres yellow.

Frons gradually narrowed above, in front of ocelli linear, orbits with hairs in a single series along inner margins; head as in *nigrihirta* in profile; facets of eyes slightly enlarged on upper halves. Presutural bristle well developed, only the prescutellar pair of dorsocentrals outstanding, the second pair and the prescutellar acrostichals weak and short; apical pair of scutellar bristles fine, about half as long as lateral pair and well before apex. Abdomen rather narrow for this group, fourth visible tergite 1·5 times as long as third, fifth curved downward and quite large, the hypopygium curved forward below abdomen. Legs stout, mid and hind femora noticeably so, the latter with many erect setulose hairs on all surfaces; hind tarsus not shorter than hind tibia. Inner cross-vein of wing at two-fifths from apex of discal cell; apical venation of wing as in Text-figure 5.

Length, 4 mm.

Type, Como, N.S.W., December, 1923 (H. Petersen).

The type specimen is in the collection of the writer, but it will be sent later to Australia for deposition in some museum there.

A female specimen taken along with the type male cannot be clearly distinguished from the female of the next species.

Hyalomyia nigrihirta, n. sp.

Male and female.—Very similar in all respects to *lepidofera*, differing in having the eyes close together on a greater extent of frons; the dorsum of thorax less densely grey dusted, without vittae, and not yellow dusted centrally behind the suture; the abdomen more broadly purplish-black on dorsum; and the hind femora black haired. In *lepidofera* the humeral angles have yellow scale-like hairs similar to those on the upper half of mesopleura, while in *nigrihirta* the hairs on the humeri and upper portion of mesopleura are black and but little widened. Head as in Text-figure 6, apical venation of wing as in Text-figure 7.

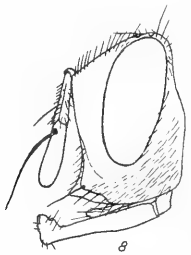
Length, 4 mm.

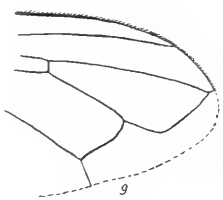
Type, male, allotype, and 11 paratypes, Seaford, Victoria (W. F. Hill). United States National Museum.

Genus Gymnosoma Meigen.

As noted in my Preliminary Catalogue of Australian Tachinidae (These Proceedings, liii, 1928, 651) Macquart recorded the European species *Gymnosoma rotundata* Meigen from Tasmania. I have not seen this species from that region and doubt its occurrence there. Lest there should be a closely related Australasian form, I figure the head of *G. fuliginosa* Robineau-Desvoidy, an American species,

and the apex of the wing of *rotundata* Meigen (Text-figs. 8, 9) as characters for the recognition of the genus.





Text-fig. 8.—Head of *Gymnosoma fuliginosa* Robineau-Desvoidy, from the side.
Text-fig. 9.—Apex of wing of *Gymnosoma rotundata* Meigen.

The European species is parasitic upon Pentatomidae, the eggs being laid on the host, which survives the emergence of the adult.

Tribe **Tachinini**.

This group as accepted herein is equivalent to the Tachininae of Lundbeck, and contains several more or less readily distinguished segregates, some notes on two of the Australian genera of which are presented below.

Gonia Group.

Characters of the group.—Prosternum setulose; hind coxae bare above bases of femora; no hairs on postnotum immediately below lower calypter; almost invariably a small bristle close to base of posterior notopleural bristle on the outer side; first wing vein bare, third setulose at base, the tip of latter well before apex of wing; second antennal segment always distinctly shorter than third; frons wide in both sexes; lower calypter with its inner margin deflected and adhering closely to contour of scutellum and postalar declivity, slightly bulging up just inside of margin.

There are two genera of the group in the available Australian material.

Genus Tritaxys Macquart.

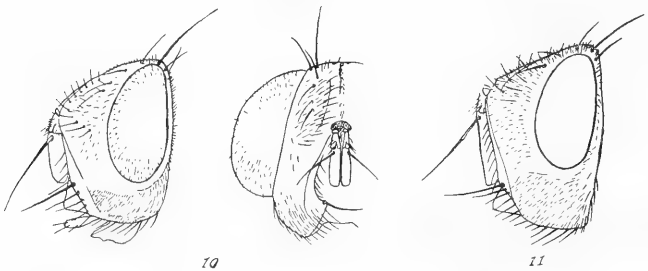
Macquart described *Gonia heterocera* in 1845, and *Tritaxys australis* in 1847, The two appear to be synonymous, as is indicated in my recently published catalogue of the Australian Tachinidae. Townsend erected the genus *Goniophania* for the reception of *heterocera*, which course would appear unnecessary if the above synonymy is correct.

Tritaxys heterocera (Macquart).

A large robust species averaging about 12 mm. in length. Head of the normal somewhat waxy pale testaceous yellow colouring of the genus *Gonia* Meigen, antennae red, third segment blackened from near base above, and from about middle below, to apex; palpi reddish-yellow. Thorax black, densely grey dusted, dorsum with four slender blackish vittae, humeral angles and scutellum, and sometimes the margins of mesonotum, showing reddish through the overlying dust. Abdomen black, sides basally showing reddish, densely dusted,

variably checkered in different lights. Legs black. Wings hyaline. Calyptrae white. Knobs of halteres yellow.

Head as in Text-figure 10; eyes with short hairs in front, almost bare behind; frons at vertex about one-third of the head width, interfrontalia not sharply defined, the bare stripe not half as wide as the bristled orbits; ocellars absent; second segment of arista about six times as long as thick. Presutural dorsocentrals and acrostichals usually in three pairs, postsutural dorsocentrals four, acrostichals three, pairs, basal abdominal tergite without apical central macrochaetae.



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Text-fig. 10.—Head of *Tritaxys heterocera* Macquart, from side, and in front (one side).
Text-fig. 11.—Head of *Anamastax goniaeformis* Macquart from the side.

Localities, French's Forest, N. Sydney, N.S.W., 14.xii.1923, and Como, N.S.W., various dates in November (T. G. Campbell); King George's Sound, Western Australia. All from the Australian Museum.

Genus Anamastax Brauer and von Bergenstamm.

Anamastax goniaeformis (Macquart). Text-fig. 11.

A species of rather similar appearance to the preceding one, but more robust and with the abdomen more conspicuously reddish on basal half or more. Structurally the species differ in that the second segment of the arista here is hardly longer than thick, the eyes are bare, the parafacials are not entirely haired, the antennae are comparatively shorter, the facial ridges are more strongly bristled, and the apex of abdomen in the female is more copiously bristled.

Length, 13-15 mm.

Locality, King George's Sound, W. Australia, no other data. Australian Museum.

Tribe **Actiini.**

This tribe consists of small species which rarely exceed 5 mm. in length, that have the third wing vein terminating at, or very close to, apex of wing, first posterior cell of wing open, the third antennal segment always much longer than the second, frequently very broad, and occasionally cleft from near base to apex in the male, the frons broad in both sexes, parafacials always bare on the greater portion of their extent, palpi present, prosternum setulose, notopleurals two in number, lower calypter large, subtransverse on hind margin, not deflected on inner

margin nor with a submarginal elevation, and the hind coxae bare above femora. The face is never carinate and the arista is normally without hairs.

The genus *Actia* Robineau-Desvoidy has been given a very wide interpretation by several writers, while others have split off segregates on various characters and applied generic names to these segregates. Bezzi has dealt with the genera of Tachinidae in which the fourth wing vein is obliterated, or almost so, on the section beyond the preapical bend and he has presented a key to these genera (*Ann. Mag. Nat. Hist.*, ser. 9, vol. 27, 1926, 236). In this paper he discusses the status of *Actia* and several related genera, but in limiting himself to those in which the fourth vein is obliterated or evanescent beyond the preapical bend he naturally omits the genus *Schizotachina* Walker, introducing it in a prior paper in which he described *Schizotachina fergusoni*, the paper being upon forms in which the third antennal segment is split or subdivided (Proc. Linn. Soc. N.S.W., xlviii, 1923, 647). This genus was subsequently discussed briefly by Curran (*Ent. Mitt.*, 16, No. 5, 1927, 355), who pointed out that the North American species may be distinguished from the Australian form placed in *Schizotachina* by Bezzi on the basis of the possession of but one bristle at base of the third wing vein, whereas in *fergusoni* there are bristles up to at least the inner cross-vein. This last author proposed a new subgenus of *Actia*, *Schizactiana*, for the reception of *valida*, n. sp., and *fergusoni* Bezzi, the former being the type species.

Thus so far only *Actia* has been recorded from Australia, and before me there are three species which are referable to the genus in its broadest sense.

Genus Actia Robineau-Desvoidy.

It would appear to be worthy of note that Lundbeck in his treatment of the Danish species included species with discal bristles (*Thryptocera* Macquart), and those without such bristles, the latter group, *Actia*, *sens. str.*, containing various species groups, in which the third vein only, the first and third veins, and the first, third, and fifth veins, are setulose. Most specialists consider the presence or absence of such setulae of generic significance, and apparently Curran inclined to this opinion when he decided that the American species of *Schizotachina* were generically distinct from the Australian species with similarly cleft third antennal segment as he stated that the former "genus" was at once distinguished from the Australian forms by the presence of but a single seta at base of third vein, the others having that vein setose at least to the anterior cross-vein. I am inclined to consider *Schizotachina* as at best a subgenus of *Actia*, but at present have no occasion to express a definite opinion, as no typical species from Australia is before me.

All three Australian species which I have seen have the base of the third wing vein setulose to, or beyond, inner cross-vein, and would on this basis appear to have a closer affinity to the European group containing *fissicornis* Strobl, *nigrohalterata* Villeneuve; *bicolor* Meigen, and *anomala* Zetterstedt, than to the typical forms as represented by *pilipennis* Fallen, *frontalis* Macquart, and *crassicornis* Meigen, the first-named of these three being the genotype of *Actia*. The more recently distinguished species *nudibasis* Stein is separable by the setulae on the first wing vein being confined to its apical section, the basal half being bare, the others having the vein setulose on its entire extent, and it appears worthy of note that several Oriental species agree in this character with *nudibasis*.

The three Australian species now before me may be distinguished as below.

Key to the Species.

1. Fourth wing vein obliterated beyond the preapical bend in both sexes; third antennal segment in male simple ..... *eucosmae* Bezzi
   Fourth wing vein distinct to margin of wing 2
2. Third antennal segment of male cleft from near base to apex, the lower branch longer than the upper one ..... *fergusoni* Bezzi
   Third antennal segment simple ..... *norma*, n. sp.

ACTIA FERGUSONI Bezzi.

I have before me a male specimen which I consider belongs to this species. The antennal characters are slightly different from those in Bezzi's original description, more resembling those given by Curran for *valida*, but the aristae are both broken off at apex of second segment so that it is impossible to determine the relative lengths of the segments. I am inclined to think that there is but one species involved here. Bezzi used a hand lens almost exclusively in his work and it may be that he did not correctly gauge the lengths of the aristal segments in *fergusoni* type.

Locality, Como, N.S.W., December, 1923, swept from flowers (H. Petersen).

ACTIA EUCOSMAE Bezzi.

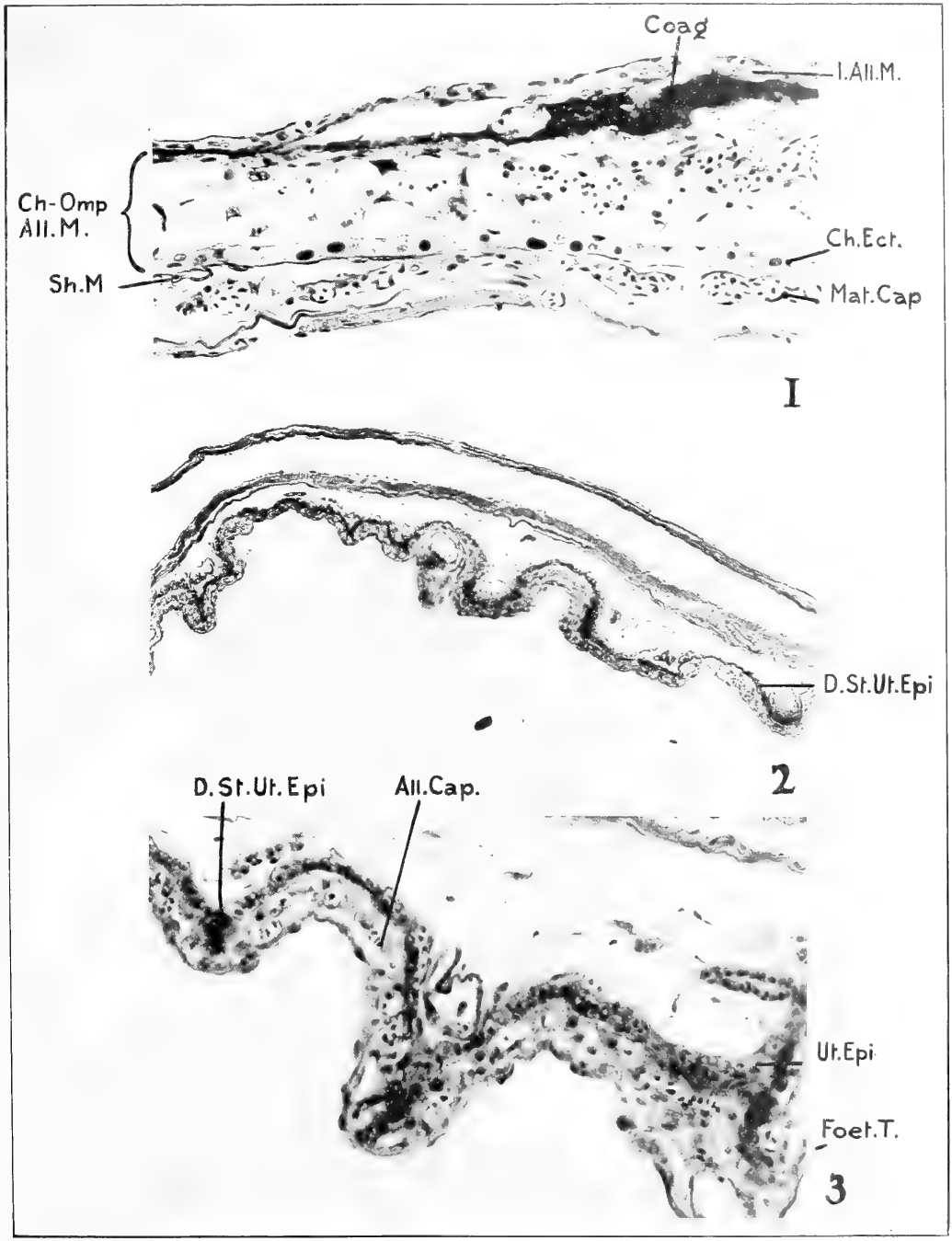
I have examined a female specimen in the United States National Museum from the same source as the type specimen of this species and have compared it with a male in my possession. The antennae in the museum specimen differ from the description given by Bezzi in being largely infuscated on third segment and in having that segment about six, and not only three, times as long as second segment. The male has the third antennal segment entirely black, and wider than that of female, with a quite evident convexity near base on the upper side, and about eight times as long as the second segment.

Locality, Como, N.S.W., December, 1923, swept from flowers (H. Petersen).

ACTIA NORMA, n. sp.

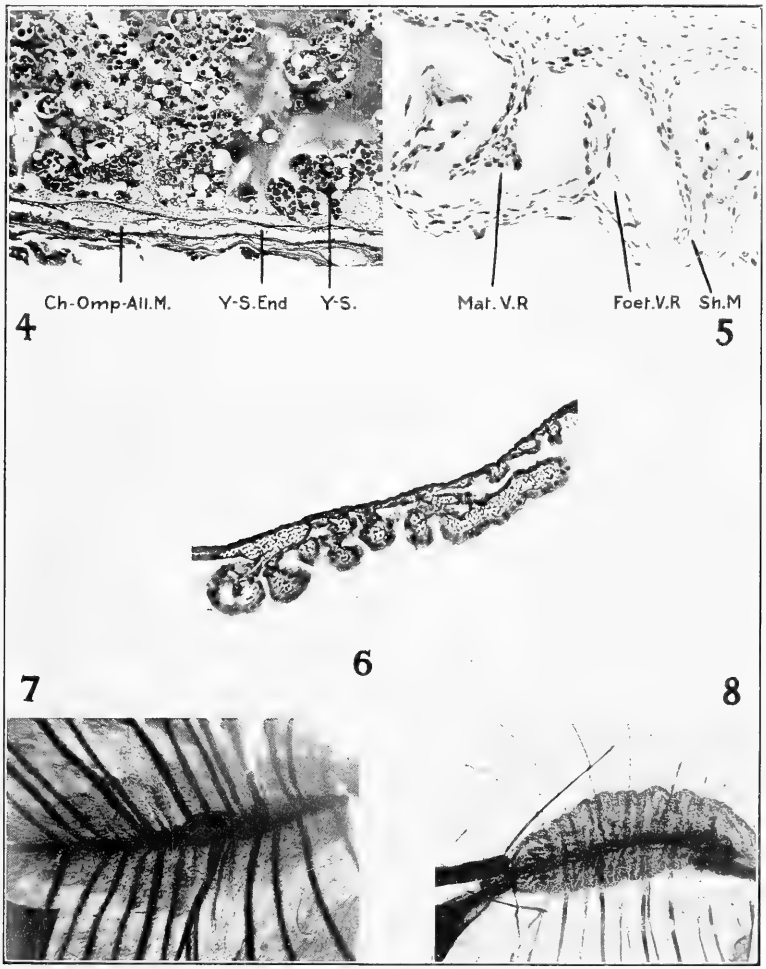
Male.—Head yellowish testaceous, face white dusted, orbits densely grey dusted, interfrontalia orange, occiput fuscous, densely grey dusted; antennae orange, third segment largely dark brown apically; aristae dark brown; palpi and proboscis testaceous yellow. Thorax fuscous, densely grey dusted, without vittae, humeri and extreme apex of scutellum showing slightly testaceous through the dust. Abdomen testaceous, tergites darkened at apices, more noticeably so on fourth, the surface with grey dust, most dense at bases of tergites. Legs testaceous yellow, tarsi slightly browned. Wings hyaline, veins dark. Calyptrae whitish. Halteres yellow.

Frons at vertex almost one-third of the head width, all four verticals strong, postverticals short and hair-like, ocellars moderate, proclinate and divergent, each orbit about half as wide as interfrontalia, inner margins with two backwardly directed bristles above, three incurved bristles on anterior half, and two forwardly directed outer supraorbital bristles, a few short fine hairs laterad of the bristles anteriorly descending to level of apex of second antennal segment; third antennal segment fully three times as long as second and one-third as wide as long; aristae tapered on basal third, second segment not much longer than thick; palpi slender; cheek not as high as width of third antennal segment. Thorax normal. Abdomen subcylindrical, a pair of apical central bristles on second visible tergite and four strong bristles at apex of third, and other four at apex of fourth tergite. Legs

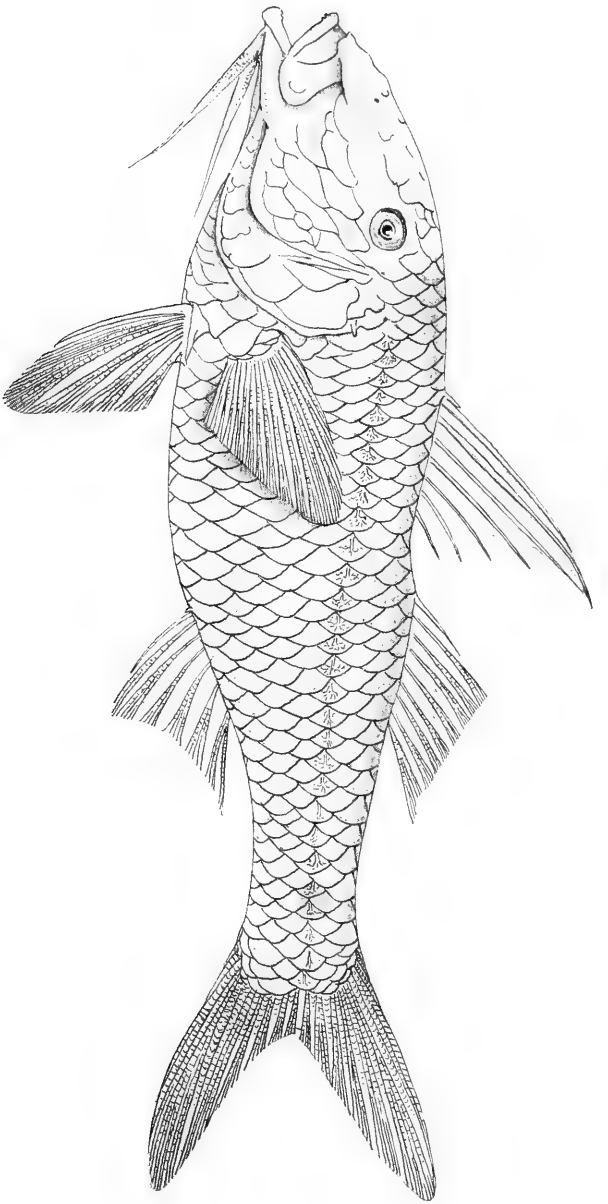


Denisonia superba.

1. Allantoplacenta in yolk-sac region. 2. Ridged allantoplacenta in embryonic region. 3. Three vascular ridges of allantoplacenta.



4. Section through yolk-sac of late stage of *Denisonia superba*. 5. Ridged allantoplacenta of *D. suta*.
6. Section of uterine wall in ridged region of *Lygosoma entrecasteauxi*. 7, 8. Elliptical placental region in *L. pretiosum* (7) and *L. entrecasteauxi* (8).



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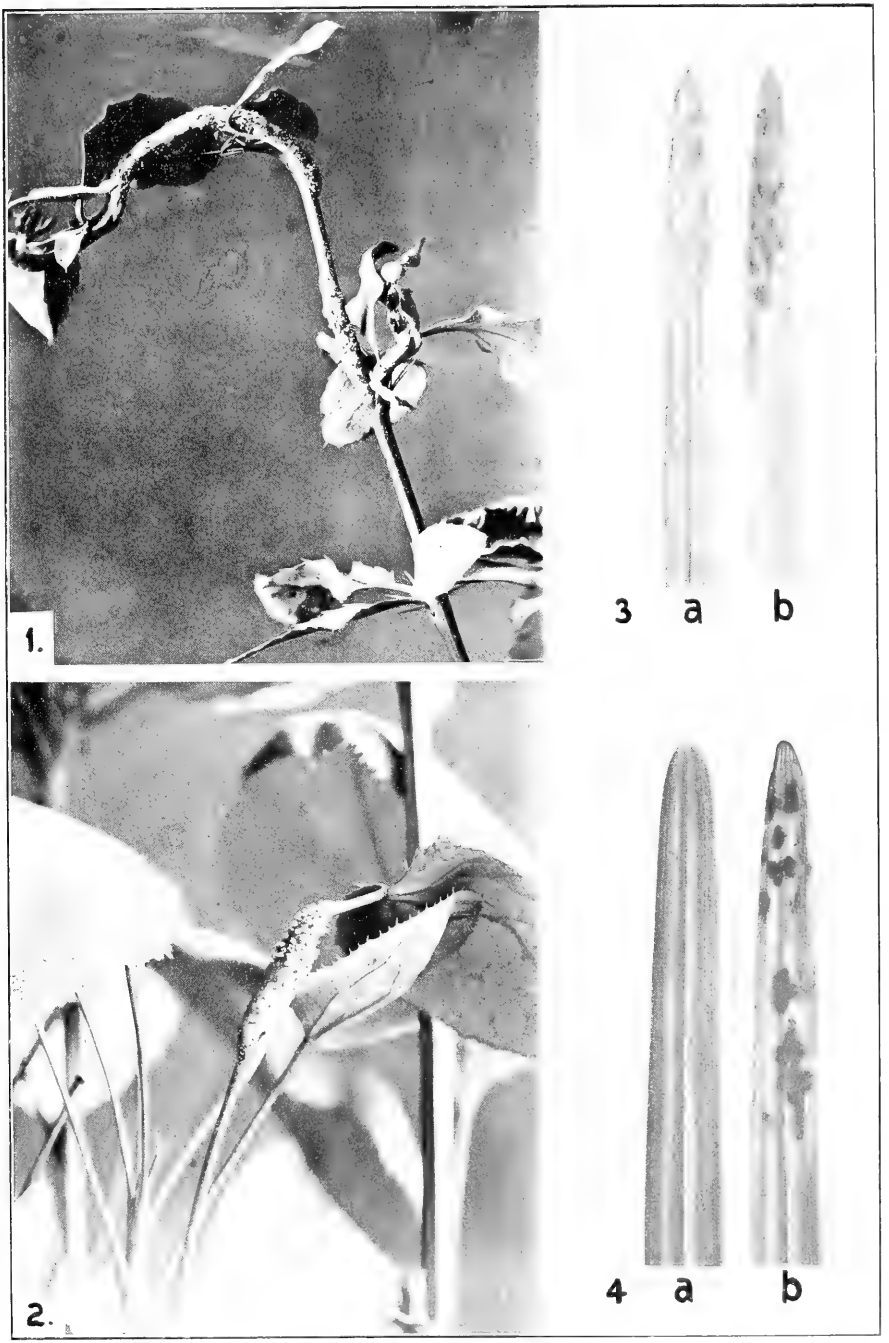
Pseudupeneus (*Hogbinia*) *filamentosus* (Macleay). × ½.



1, 2. Young shoot (1) and petiole (2) of *Berberis vulgaris* showing aecidial infection with rust.

3, 4. Leaves of Einkorn wheat (3) and Mindum wheat (4) showing resistant reaction and flecking (*a*), and susceptible reaction (*b*).

normal, hind femur with one long and one shorter preapical anteroventral bristle; hind tibia with four or five short anteroventral bristles, the most apical one longest, one posterodorsal bristle, and three or four irregular anterodorsal bristles. Inner cross-vein about two-fifths from base of discal cell, outer cross-vein about equally far from inner cross-vein and bend of fourth vein.

Length, 3 mm.

Type, Como, N.S.W., December, 1923, swept from flowers (H. Petersen).

All three species listed above were amongst some miscellaneous material sent to me by the late C. F. Baker from the Philippines, the whole having been collected for him by Mr. Petersen.

REVISION OF THE AUSTRALIAN PHORACANTHINI (FAM. CERAMBYCIDAE), WITH NOTES, AND DESCRIPTIONS OF NEW SPECIES OF THIS GROUP AND OF ALLIED GENERA.

By H. J. Carter, B.A., F.E.S.

(Six Text-figures.)

[Read 29th May, 1929.]

The group Phoracanthini needs revision. Both genera and species are much confused in Australian collections, and the catalogues—even the latest (of Junk, Berlin)—contain many inaccuracies. Thanks to the courteous help given me, I have been able to examine many types, as well as long series of most of the recorded species. I wish to acknowledge my obligations to the following: Dr. G. A. K. Marshall (Imperial Bureau of Entomology), Messrs. K. G. Blair (British Museum), J. Kershaw (National Museum, Melbourne), A. M. Lea (South Australian Museum), A. J. Nicholson, J. Shewan (Macleay Museum), A. Musgrave (Australian Museum), H. Hacker (Queensland Museum) and J. E. Dixon, of Melbourne, for the loan of examples.

I have to acknowledge my indebtedness to Mr. Cedric Deane, A.M.I.E.Aust., for the six drawings of the Phoracanthini, also to apologize for the absence of an acknowledgment for his four figures of Buprestidae in my former paper (These Proceedings, Part 2, April, 1929), and also to Mr. E. H. Zeck for his figure of *Rhyssonotus costatus* in the same paper.

The insects of this group are in many cases common and widely distributed over the continent as "borers" in various species of *Eucalyptus*. The adult imagines occur frequently under the loose bark, so characteristic of these trees, and indeed are often known as "firewood" beetles, from their prevalence in this; but they also frequent the flowers of these trees, as also of *Leptospermum* and *Angophora*. Some of the species have been introduced into other countries, no doubt with their associated species of *Eucalyptus*. Thus *Phoracantha semipunctata* F., has now a wide distribution through South Africa (Zululand, Transvaal and Rodriguez specimens in British Museum), while *Coptocercus trimaculatus* Hope appears to have been redescribed by Fauvel as a New Caledonian species (*vide infra*).

The chief characters of the group are: Head short, antennae with at least the third segment spinose, eyes coarsely granulate, pronotum more or less nodulose on disc, generally spinose or tuberculate at sides; anterior coxal cavities open, the intermediate closed behind.

The line dividing the subfamilies Phoracanthini and Callidiopini is not easy to define. A spine on the third antennal segment is present in *Acyrusa*, in the insect described by Blackburn as *Bethelium spinicorne* (recently taken by the author in

the Queensland National Park, MacPherson Range), and in two species of *Sisyrium* before me that are otherwise inseparable from the genus. Further, *Acyrusa* and *Bethelium spinicorne* appear more nearly related to the Phoracanthini than are either *Porithodes* or *Skeletodes*. Lacordaire stated that only the close likeness between *Acyrusa* and *Sisyrium* prevented his inclusion of *Acyrusa* under the Phoracanthides. This likeness is intensified in the case of *A. tasmanica* Gah., while the two species of *Sisyrium* before me having the third antennal segment spinose still further increase this affinity. Again, *Porithodes* is near *Bethelium* in its comparatively short prothorax, simply rounded at sides without lateral spines or tubercles, and the elytra without eburneous elevations. In this last character *Bethelium spinicorne* approaches the Phoracanthini.

Without undue splitting of genera on the single character of the spinose antennal segment it appears best to adhere to the combination of characters mentioned above as limiting the subfamily, which in my opinion includes only the genera of my tabulation as follows; though, in the light of certain species of *Sisyrium* having spinose antennae, there seems to be some claim for this genus also to be included:

Australian Genera of the Phoracanthini.

1.	Femora linear, or gradually thickened	2
	Femora clavate, pedunculate at base	7
2.	Antennal segments bispinose	3
	Antennal segments unispinose	4
3.	Sides of prothorax spinose or pustulose	*Tryphocaria*
	Sides of prothorax lightly rounded	*Yorkeica*
4.	Sides of prothorax bispinose	*Demelius*
	Sides of prothorax unispinose	5
	Sides of prothorax pustulose	6
5.	Apices of elytra bispinose	*Phoracantha*
	Apices of elytra truncate	*Coleocoptus*
6.	Anterior tibiae arched, antennal segments 3-7 or 8 spinose	*Epithora*
	Anterior tibiae straight, antennal segment 3 only spinose	*Atesta*
7.	Antennal spines well developed on 3 to 6 or 7	*Coptocercus*
	Antennal spines little developed on 3-5 at most	8
8.	Elytra with eburneous elevations arranged transversely	*Allotisis*, subgen.
	Elytra with round eburneous elevations arranged longitudinally	*Thoris*
	Elytra without eburneous elevations	*Skeletodes*

The distinction between *Coptocercus* and *Allotisis* is very finely drawn, the latter being at most a subgenus. The very different facies of *Thoris* and *Skeletodes*, however, warrants their separation. In the latter I find the antennal segments 3-5 clearly bispinose. Pascoe, in describing *Elete*, mentions only the spine on the third segment.

Tryphocaria Pasc. Genotype, *T. hamata* Newm.—Pascoe distinguished this genus from *Phoracantha* by (1) its small prothorax in proportion to elytra, (2) more linear femora, (3) forehead more narrowed in front, (4) shorter antennae, (5) antennal segments 3-8 bispinose at apices (in *Phoracantha* 3-6 simply spinose). To these Blackburn appended "It may be added that the antennae have a more or less distinct indication of a twelfth joint." (These PROCEEDINGS, 1888, p. 1457).

The last statement is erroneous. Both in *Phoracantha* and *Tryphocaria* the eleventh segment (the term "joint" should be limited to the "articulation" between segments, though long carelessly employed as synonymous with segment) has an apical portion compressed, this portion sometimes emphasized by a ring of minute

setae, that at a casual glance does give a suggestion of an extra segment, but there is no articulation at this ring and the binocular microscope clearly shows the nature of this pseudo-segment.

In the description of *T. punctipennis*, Blackburn goes further to state "antennae . . . having 12th joint well developed and perfectly distinct from the rest; it is about $\frac{1}{3}$ as long as the 11th joint." (These PROCEEDINGS, 1888, p. 1462). Now I have before me an example from the South Australian Museum labelled in Blackburn's handwriting as *T. punctipennis* Blackb., that is most probably the ♀ from Fowler's Bay described in his note under *punctipennis*. In this example the typical pseudo-segment is not more strongly developed than in many examples of *T. hamata* Newm. Of the five characters above, said to distinguish *Tryphocaria*, only (1) and (5) are of wide application or of practical use, the others varying with the species and (3) being of doubtful occurrence.

With regard to (1) the relatively small prothorax, I have taken measurements of all the *Tryphocaria* and of several *Phoracantha* and find that of the eleven species regarded as valid in my tabulation, six can be definitely so distinguished, namely, *hamata*, *mastersi*, *odewahni*, *longipennis*, *punctipennis* and *frenchi*, the other four differing little or not at all in this respect from *Phoracantha*. Thus the only real generic distinction of *Tryphocaria* lies in the nature of the antennae, unless a special genus be raised for these four, which seems undesirable. As to the number of spinose segments, there is some specific and even individual variability throughout the whole group. Pascoe says of *Phoracantha*, "3-6 apice spinosis", but his genotype *P. semipunctata* F., has 3-7 spinose, as also have the majority of species. Of *Tryphocaria* Pascoe says "3-8 apice bispinosis", but the eighth is often obsoletely spined in the genotype *hamata*, while in examples of *T. mastersi* before me only 3-6 are spined.

Xypeta Pasc.—The author distinguished this genus from *Tryphocaria* by (1) forehead widened in front, (2) short anterior legs and the unusual length and slenderness of the remainder. Again, in his note under *X. grallaria*, he states "one of the most remarkable of the whole subfamily, owing to its very short anterior legs and the unusual length and slenderness of the remainder."

As regards slenderness, I find no distinction from *Tryphocaria*, nor is there anything in the width of the front that deserves special distinction; there remains then only the length of the legs, or rather the ratio of the respective lengths of the front to the hind legs. I have, therefore, made careful measurements of typical specimens of *X. grallaria*, *T. hamata* and *Ph. gigas* Hope (= *tricuspis* Newm.), the last of which has been placed under *Xypeta* by Dr. Aurivillius in the Junk Catalogue, a position suggested by Blackburn. The following are the results:

	Dimensions of example in mm.	Front femur.	Front tibia.	Hind femur.	Hind tibia.
X. grallaria ♂	42 × 14	9	8	17	14·5
T. hamata ♂.....	36 × 11	10	8	17·5	14
Ph. tricuspis ♂	45 × 12	12·5	10	21	17

If these results be standardized for an insect of common length, 36 mm. long, we get:

	Dimensions of example in mm.	Front femur.	Front tibia.	Hind femur.	Hind tibia.	Ratio front : hind leg.
X. grallaria	36	8	7	14	12	18 : 31
T. hamata ..	36	10	8	17·5	14	18 : 31·5
Ph. tricuspis	36	10	8	17	14	18 : 31

Clearly there is so little to distinguish the first two of these that I can only consider *Xypeta* as synonymous with *Tryphocaria*, or at most, a subgenus.

In *tricuspis*, the more robust femora, the simply spined antennae and narrower form proclaim it to be a *Phoracantha*. This, as with other species, is very variable in size, while the legs are much shorter in female examples.

Tryphocaria punctipennis Blkb.—Seven examples (4 ♂, 3 ♀) are before me, including a ♂ that has been compared with type, and the ♀ (from the South Australian Museum) that is probably the specimen described by Blackburn from Fowler's Bay. It is named and labelled by this author. The males are rather like some examples of *T. odewahni* but are less convex, the elytral costae are less defined and the apices are clearly bispinose. I think it is a good species.

Tryphocaria princeps Blkb.—Mr. Lea has lately, while visiting Sydney, very kindly brought the type of this for my examination. It might be considered a variety of *T. hamata* Newm., but there are certain differences which warrant its separation until further material is obtainable. These differences are (1) prothoracic spines shorter and straight, (2) elytra with dark basal fascia, (3) preapical fascia replacing the usual oval macula. The following species are undescribed:

TRYPHOCARIA IMMACULATA, n. sp. Text-fig. 1.

♀. Elongate, subcylindric, subnitid. Head, pronotum and underside brownish-black, elytra and appendages reddish-brown, the former darker at shoulders, base and basal two-thirds of suture. Head and pronotum sparsely, elytra very sparsely, underside finely and densely clothed with pale pubescence.

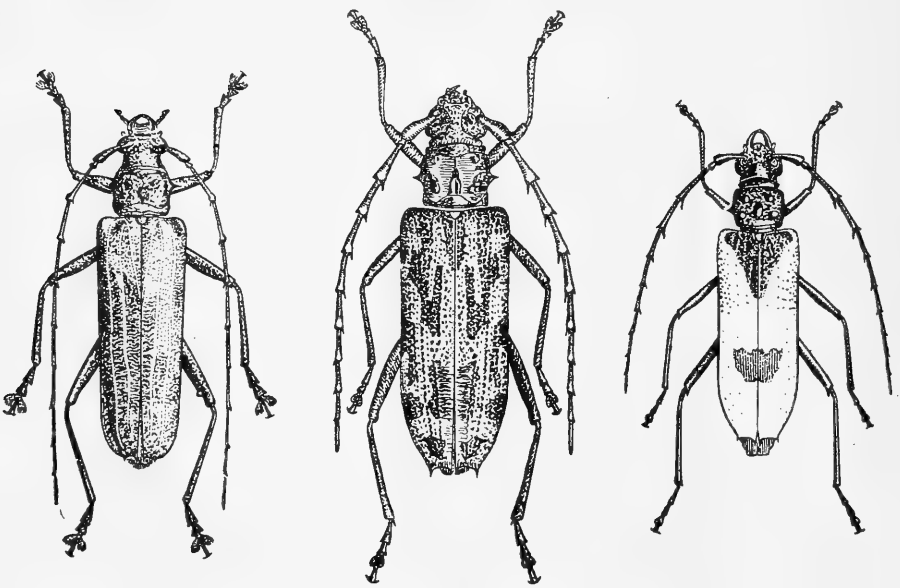
Head finely rugose-punctate, sulcate on front, antennae extending to about two-thirds the length of elytra; segments 3-6 bispinose at apex, the exterior much more evident than the interior, in 7-10 the apices only a little produced; 3-10 successively shorter than preceding, 11 slightly longer than 10. *Prothorax* 4 × 5 mm., with strong lateral spines slightly recurved at apex; disc with 5 nitid tubercles, the medial one elongate, interspaces rugose-punctate. *Scutellum* dark brown, pubescent, triangular with rounded sides. *Elytra* 30 × 11 mm., subcylindric; shoulders rather prominent and nitid, apices subtruncate between two short spines (in one example the exterior spine subobsolete); basal half of elytra coarsely subreticulately punctate, the two feebly indicated costae forming wider intervals along their length, these disappearing at apical third, punctures gradually decreas-

ing in size on apical half but strong and close to extreme apex, with some rugosity; metasternum finely and closely punctate, abdomen minutely and sparsely so.

Dim.—40-41 × 11 mm.

Hab.—Australia (Parry and Fry Collections in British Museum).

Two examples, both ♀, are amongst the Phoracanthini sent from the British Museum. One has a label on which what appears to be 'Goulburn River' is illegibly written. It is nearest in form to some examples of *T. odewahni* Pasc., but besides the absence of any dark spot, or pattern on the elytra, the lateral spines are longer than in Pascoe's species and slightly recurved. In *T. odewahni* these spines are usually very short, sometimes mere tubercles, while the elytral



Text-fig. 1.—*Tryphocaria immaculata*, n. sp.
Text-fig. 2.—*Tryphocaria placenta*, n. sp.
Text-fig. 3.—*Tryphocaria triangularis*, n. sp.

apices are often rounded off externally. The sculpture of *odewahni* differs, always showing the two subcostae much more distinctly, with an even closer rugose-punctate surface, more cellulose-punctate at base, with less defined punctures on apical half. Such examples of *odewahni* as are most nearly concolorous are very dark, almost black, whereas the general coloration of *immaculata* is that of the ground colour of *T. hamata* Newm. The ratio of the length of prothorax to that of elytra is at its minimum in this species.

Holotype in British Museum.

Note.—Since mailing the British Museum specimens for return, I have seen a male example of the above from the collection of Mr. F. E. Wilson, taken by him in the Grampians, Victoria. The antennae are longer than the body, the colour differs in the almost total absence of "black" from the upper surface;

the apical structure is as noted in the second example above (exterior spine subobsolete), and the dimensions 35 × 9 mm.

TRYPHOCARIA PLACENTA, n. sp. Text-fig. 2.

♂. Elongate-oblong; above opaque brownish-black, elytra mottled with vague pale markings; beneath black, rather densely clad with pale grey recumbent pile; antennae and femora black, the former with apices of segments red, the apices of tibiae and the whole tarsi red.

Head rugose, antennae not as long as body, segments 3-7 bispinose. *Prothorax* very sparsely pilose, with lateral conical spines, disc with four irregular nitid tubercles, the middle area with a longitudinal carina bifurcating behind. *Scutellum* black, triangular. *Elytra* considerably wider than and more than four times as long as prothorax; apices bidentate, the external spine the longer; disc coarsely cellulose-punctate, the punctures large and deep, smaller only at extreme apex, interstices very narrow, slightly widened only at the pale markings.

Dim.—38 × 10 mm.

Hab.—Queensland: Townsville (F. P. Dodd in British Museum), Mulgrave (French Collection in National Museum, Melbourne).

Two examples examined show a very distinct species, the general colour of which is that of a dull mottled plum-cake, which has suggested its name. The only tendency to arrangement of colour lies in an ill-defined preapical fascia, preceded by a black rectangular sutural blotch, the apex itself black. The usual subcostiform impressions seen on most species are here scarcely traceable. The Melbourne Museum example has only three legs, though otherwise perfect.

Holotype in British Museum.

TRYPHOCARIA TRIANGULARIS, n. sp. Text-fig. 3.

♀. Elongate oblong. Head, pronotum, underside and elytral markings chocolate-brown; antennae, legs and ground colour of elytra testaceous; the dark elytral markings consisting of (1) a basal triangle extending longitudinally to the basal third, with apex at suture, its base not extending to shoulders, (2) a postmedial squarish patch extending laterally about half-way over each elytron (in three examples this broken up into two more or less widely separate maculae), (3) suture, narrow margins, and apical spines.

Head lightly punctate, medial frontal channel well marked, antennae not quite the length of body, segments 3 to 7 or 8 bispinose. *Prothorax* nitid and impunctate, very sparsely pubescent, with two straight lateral spines, disc embossed with five smooth tubercles, four being round, the fifth (medial) elongate-ovate. *Scutellum* triangular, pilose. *Elytra* parallel, about four times as long as prothorax, apices truncate between two long spines, surface punctures not very close, moderately large at base, soon decreasing in size behind and subobsolete on apical third, intervals not at all rugose, two evident subcostiform lines on each. Whole underside with a fine, dense, recumbent pile; femora linear, their apices sharply spinose.

Dim.—25-30 × 8-9 mm.

Hab.—Queensland: Stanthorpe (National Museum, Melbourne), Townsville (Dodd) and Brisbane (in British Museum); two without locality label (Relton bequest in Queensland Museum).

Five examples examined are in size and general character nearer *T. mitchelli* Hope than any other, but, besides clear distinction in their elytral pattern, they

have less robust antennae with more elongate spines, while the apical spines of the femora are peculiar. All the examples are ♀, the two Queensland Museum specimens having mutilated antennae.

Holotype in the National Museum, Melbourne.

Table of Tryphocaria.

1.	Elytra quite or nearly concolorous	2
	Elytra more or less patterned	5
2.	Each elytron with two evident costae	3
	Elytra without costae	*placenta*, n. sp.
3.	Elytra subnitid, concolorous rufo-fuscous	*immaculata*, n. sp.
	Elytra subopaque, darker, or if paler, showing two dark spots	4
4.	Elytral apices spinose only at suture	*odewahni* Pasc.
	Elytral apices clearly bispinose	*punctipennis* Blkb.
5.	Apical area widely obfuscate	6
	Apical area not so	7
6.	Sides of prothorax spinose	*frenchi* Blkb.
	Sides of prothorax tuberculose	*mastersi* Pasc.
7.	Form narrow, margins narrowly dark	8
	Form wider, margins concolorous with disc	9
8.	Premedial markings (if present) longitudinal	*longipennis* Hope
	Premedial markings consist of a basal triangle	*triangularis*, n. sp.
9.	Elytra about six times as long as prothorax	10
	Elytra about four and a half times as long as prothorax	11
10.	Lateral spines of prothorax recurved	*hamata* Newm.
	Lateral spines of prothorax straight	*princeps* Blkb.
11.	Elytra largely testaceous, post medial markings cruciform	*mitchelli* Hope
	Elytra deep red, heavily blotched with black	*solida* Blkb.*

Synonymy.—(*a*) *T. hamata* Newm. = *Phoracantha acanthocera* Hope = *uncinata* Blkb. (*b*) *T. longipennis* Hope = *superans* Pasc. = *hamata* Blkb.

With regard to (*a*), the only examples labelled *acanthocera* that I have seen are in the Macleay Museum Collection as from Swan River. These are possibly the examples from which Hope published his description (*Proc. Zool. Soc. Lond.*, 1840, p. 40), attributed by him to Macleay, and terminating with the words "In Mus. Dom. Macleay." This description gives no dimensions, nor locality. The examples are undoubtedly *T. hamata* Newm.

The other synonyms have been previously recorded, except that of *T. superans* Pasc. In this case the close similarity of description, and the fact that both are described as from Tasmania, point to the synonymy of Pascoe's species with *longipennis* Hope. I have seen many examples from Tasmania and have taken it myself, but have not met with any other species from that region. No two examples of this are quite alike, the apical third being sometimes brownish, this darker area tending to disappear to a varying degree.

Phoracantha Newm.—Genotype *P. semipunctata* F.—The Junk Catalogue, edited by Dr. Aurivillius, records twenty-one species and four synonyms. I think I have identified all these except *P. imperialis* Perroud from New Caledonia and *P. tunicata* W. S. Macl. From information courteously sent by Dr. Marshall and by Mr. Blair, *P. imperialis* Perr., from its different prothorax, *inter alia*, is clearly not a *Phoracantha*, and probably requires a new genus for its reception.

P. tunicata W. S. Macl.—The description of this is very imperfect, chiefly referring to colour and omitting dimensions and habitat. Hope (*Proc. Zool. Soc. Lond.*, 1840) placed this under his Sect. 2. Tubericolles. "Antennis spinosis, thorace tuberculato, haud spinosa, apicibus elytrorum bidentatis femoribus que

* Colour, pattern and size very like *Phoracantha synonyma* Newm.

incrassatis", whereas the description contains the words "thorace subcylindricis utrinque unidentato". If, then, Hope merely copied the description without seeing the type one must conclude that it was wrongly included in this Section. Though Hope stated that it was in "Mus. Dom. Macleay" I can find no specimen bearing this name in the Macleay Museum. If, however, Hope's classification be correct, the words "femoribus incrassatis" suggest *Coptocercus* for this species.

P. savesi Fauv. = *Coptocercus trimaculatus* Hope, as recorded by Mr. C. J. Gahan for New Caledonian examples in the British Museum; evidently introduced, as *P. semipunctata* F. has been introduced into South Africa (Zululand, Transvaal and Rodriguez in British Museum). Omitting these, as well as four other synonyms noted below, and three species which belong to other genera, my tabulation contains eleven valid species to which three new species are appended, bringing the total number to thirteen (omitting the doubtful *P. tunicata* Macl.).

Always, or nearly always, associated with the *Eucalyptus* tree, the species of the genus have a wide continental distribution and, as is almost invariably the case in such distribution, there are great and puzzling variations which appear to connect different species by gradual slight differences. Thus six of my names belong to species having in common the following dark elytral markings: (1) a premedial zig-zag fascia; (2) a dark preapical fascia or blotch; (3) variable basal markings. Of these six two, *semipunctata* F. and *tricuspis* Newm., are distinct and well-known in collections. The other four, *synonyma* Newm., *impavida* Newm., *lata* Hope and *elegans* Blkb., might be considered as merely well graded subspecies. *P. synonyma* Newm. has ground colour dark red, the darker markings heavier and more extensive, especially at base. In the other three the form is more generally elongate, the ground colour testaceous or pale, and may be distinguished as follows: *P. lata* Hope has the post-medial markings limited to an isolated oval or oblong sutural macula (This is the form figured by Tillyard, R.63, Insects of Australia and New Zealand); *P. impavida* Newm. is a western race of more opaque pale colour and of narrower form (the only example that I have seen definitely labelled *impavida*, in the South Australian Museum, is, I consider, *lata* Hope); of *P. elegans* Blkb., besides an example compared with type, sent by Mr. Blair, I have only seen one other (in Mr. Lea's collection, from Geraldton, W.A.) which differs from *impavida* in smaller size, and the prevalence of testaceous ground colour, the only dark markings being a very narrow zig-zag premedial fascia and a narrow post-medial fascia vaguely extending to the sides. This species very doubtfully deserves distinction and may probably be found to merge into *impavida* Newm.

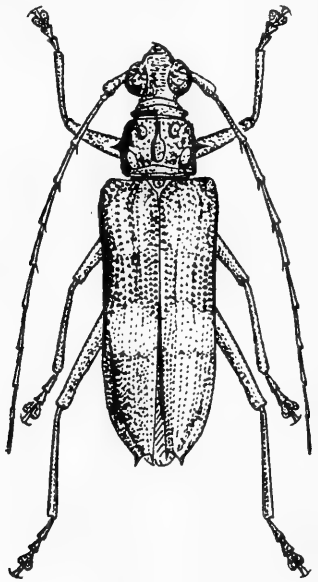
The monotypic subgenus *Diospides* Pascoe is distinguished from *Phoracantha* by the linear femora and tibiae of *D. obscura* Don.

PHORACANTHA ALTERNATA, n. sp. Text-fig. 4.

Elongate-oblong. Head, prothorax and underside dark brown, sometimes castaneous, the first very sparsely pubescent, the last densely so; elytra castaneous, subnitid and glabrous, with three wide, nearly straight bands testaceous, the first basal, the second post-medial, the third apical; antennae and legs castaneous, the latter testaceous beneath.

Head coarsely, unevenly punctate, medial sulcus wide, antennae longer than body in ♂, not quite extending to apex in ♀, segments 3-6 unispinose. *Prothorax*:

Sides strongly spinose, disc with four well-raised, rounded tubercles and a medial, nitid, elongate, tuberculate prominence having a depression within it, interspaces rugulose. *Elytra* parallel, apices strongly bispinose, external spine the longer, disc coarsely reticulate-punctate on basal half, the punctures gradually diminishing in size from base to apex, the apical third still distinctly and closely punctate;



Text-fig. 4.—*Phoracantha alternata*, n. sp.

the usual subcostiform impressions subobsolete or indicated only by wavy lines of intervals slightly wider than the rest. Metasternum lightly punctate, rest of underside finely pubescent. Legs very long, hind femora almost extending to apex of abdomen.

Dim.—♂. 25-28 × 6-7 mm.; ♀. 28-33 × 7-10 mm.

Hab.—New South Wales: Monaro (Macleay Museum); Victoria: Mt. Macedon, Gisborne (National Museum, South Australian Museum, and Mr. Lea's collection), Mallee District (National Museum), Diamond Creek (South Australian Museum).

Thirteen examples examined are unusually uniform in form and colour. The species can only be confused with *flavopicta* Pasc., from which the following comparison will distinguish it:

flavopicta Pasc.	*alternata*, n. sp.
lateral spines of prothorax very short	unusually robust
pronotum opaque, strongly pubescent	nitid, sparsely pubescent
medial pale markings of elytra "somewhat oblique to form a rough cross"	wider and straight
apical pale markings an elongate, isolated oblong	more or less covering apex

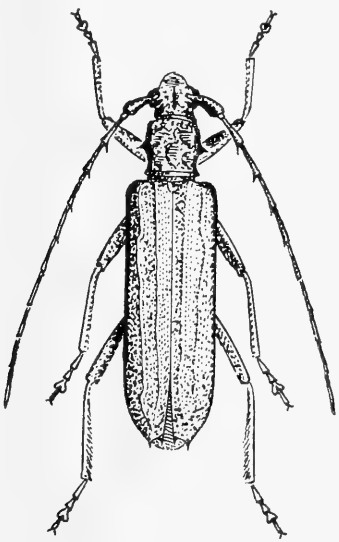
P. flavopicta Pasc. appears to have the wider distribution, specimens before me bearing labels as from Cunnamulla (Q.), Gunning (N.S.W.), Mulwala and Mallee District (Vict.), Kangaroo Island, Port Augusta and Ardrossan (S. Aust.).

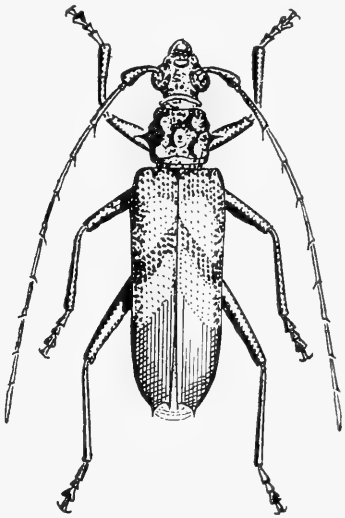
Holotype ♂ in Macleay Museum; allotype ♀ in National Museum, Melbourne.

PHORACANTHA CONCOLOR, n. sp. Text-fig. 5.

Elongate-oblong. Head and pronotum black, elytra dark brown, subnitid, sometimes paler towards apex. Head and pronotum moderately, elytra very sparsely, underside densely and finely pubescent.

Head finely and closely rugose, antennae not quite as long as body in ♂, shorter in ♀, segments 3-6 simply spined on the outside, 3-11 subequal in length, successively narrower, 11 much narrower than 10, and showing pseudo-segment marked by ring of setae. *Prothorax* with lateral conical spines; sulcate and constricted at apex and base, disc with four nitid, somewhat rounded and flattened tubercles, a fifth (medial) more or less elongate; interspaces irregularly rugose.





Text-fig. 5.—*Phoracantha concolor*, n. sp.
Text-fig. 6.—*Phoracantha porosa*, n. sp.

Scutellum triangular, pubescent. *Elytra* wider than, and at least four and a half times as long as, prothorax, apices strongly bispinose, exterior spine the longer; disc coarsely and subseriately punctate at basal third, the punctures thence gradually diminishing in size, becoming denser and less regular but clearly visible to extreme apex; two well-raised costiform lines on each underside, the sculpture hidden by dense recumbent pubescence.

Dim.—♂. 25 × 7 mm.; ♀. 29 × 8 mm.

Hab.—New South Wales: Blue Mountains (H. J. Carter, in National Museum and Macleay Museum; G. E. Bryant, in British Museum), Goulburn (in South Australian Museum).

Five examples before me show a rather narrow parallel species, readily distinguished by the absence of any pale marking or pattern on the elytra.

Holotype ♂ in Macleay Museum; allotype ♀ in the National Museum, Melbourne; paratype in British Museum.

PHORACANTHA POROSA, n. sp. Text-fig. 6.

Oblong, glabrous above. Head and prothorax nitid, dark castaneous brown, elytra red with wide apical area and a narrow medial fascia black, or nearly so; antennae, legs and underside pale red, the last with fine, dense, recumbent pubescence.

Head closely punctate, medial frontal sulcus distinct; antennae longer than body in ♂, about as long as body in ♀, segments 3-7 strongly spined on outside; 3 longer than 4, 4-11 subequal in length, gradually lessening in width, 11 very narrow, with short inconspicuous apical pseudo-segment. *Prothorax* with two well-developed lateral spines, disc with four rounded and nitid tubercles, a fifth (medial) elongate and sulcate; interspaces coarsely and irregularly punctate, the punctures often invading the tubercles. *Scutellum* triangular with rounded sides, pubescent. *Elytra* wider than, and about four times as long as, prothorax, apices truncate, between two long spines, exterior the longer; shoulders prominent, sides slightly narrowing to the dark posterior region, thence arcuately narrowed to apex; disc very coarsely and subseriately cellulose-punctate, the punctures round and contiguous except where lines of slightly wider intervals form vague subcostiform lines; the large punctures rather abruptly ceasing at the dark apical area, this sublaevigate and nitid. Legs very long, in ♂ the hind femora extending to the apex of body.

Dim.—♂. 19-21 × 5 mm.; ♀. 25 × 6·5 mm.

Hab.—South Australia: Gawler (Pascoe Collection in British Museum), Quorn (South Australian Museum).

Three examples (one merely labelled Australia, in British Museum) show a rather short species that is very distinct by reason of its characteristic coarse sculpture as well as by its elytral markings. The dark markings are a narrower fascia extending from the middle of the sides and directed obliquely forward to form an acute angle at the suture; a large apical area of which the middle part is extended forward, so that its anterior margin is roughly parallel to the fascia. On the ♂ examples there is a small indistinct paler area that includes the exterior spine and its immediate vicinity. In the ♀ example the dark apical patch tends to become reddish towards apex. In colour the species is most like *P. synonyma* Newm., from which it may be readily separated by (1) different markings, (2) coarser punctures of elytra, (3) sublaevigate apical area, (4) longer antennae and legs.

Holotype ♂ in British Museum; allotype ♀ in South Australian Museum.

Table of Phoracantha.

1.	Dark elytral markings as mentioned for six species above	2
	Dark elytral markings otherwise	7
2.	Elytra having a more or less square testaceous area between wide and straight bands of black (or dark brown)	*semipunctata* F.
	Elytral pattern otherwise	3
3.	Size very large, 35 mm. long or more, legs very long	*tricuspis* Newm.
	Size less than 35 mm. long	4
4.	Postmedial markings an isolated macula	*lata* Hope
	Postmedial markings irregularly fasciate	5
5.	Ground colour of elytra castaneous or red	*synonyma* Newm.
	Ground colour more or less testaceous	6
6.	Dark markings of elytra wider, size larger	*impavida* Newm.
	Dark markings of elytra very narrow, size smaller	*elegans* Blkb.
7.	Elytral pattern consists of three pairs of testaceous maculae	8
	Elytral pattern otherwise	11

8. Ground colour black, testaceous markings very narrow, anterior pair often sub-obsolete ..... *quinaria* Newm.
   Ground colour castaneous, pale markings wider 9
9. All markings with nearly straight margins ..... *alternata*, n. sp.
   Premedial dark fascia undulate 10
10. Pale markings oblique forming a rough X ..... *flavopicta* Pasc.
    Pale markings more extensive, medial pale fascia with straight hind margins .... *laetabilis* Blkb.
11. Spines on third segment of antennae recurved ..... *recurva* Newm.
    Spines on third segment of antennae normally straight 12
12. Apical area widely dark, surface coarsely reticulate-punctate ..... *porosa*, n. sp.
    Elytra concolorous, not closely punctate ..... *concolor*, n. sp.

Synonymy.

(1) *quinaria* Newm. = *punctata* Don. = *fallax* Pasc. = *hospita* Pasc. = var. *posticalis* Blkb.

(2) *semipunctata* F. = *inscripta* Germ.

(3) *synonyma* Newm. = *punctata* Kirby (*nec* Don.).

(4) *tricuspis* Newm. = *gigas* Hope = *gigas* Angas = *robusta* Germ.

With regard to (1), *punctata* Don. holds the claim for priority, but there is some uncertainty associated with it; the figure given by Donovan is not very accurate. The synonymy is based on Mr. Blair's note attached to a typical example of *quinaria* Newm. "= *punctata* Don. according to a specimen so named in Hope Coll. as from sale of Donovan's insects." *P. hospita* Pasc., is only a small form, while *posticalis* Blkb. (a cotype is before me labelled by Blackburn) is only a *quinaria* in which the apical pale marking is absent. My series shows every gradation towards this tendency.

(4). I have little doubt of this from the series examined. The sexual distinction is strongly marked, not only in the longer antennae, but also in the longer legs of the ♂.

Coptocercus Hope.—"Caput antice rugosum, antennis spinoso-tomentosis. Thorax fere cylindricus, tuberculatus. Elytra parallela, thorace latior, ad apicem parum contracta, transversa fissa, haud spinosa. Corpus infra connexum, antennis pedibusque fere ut in *sten*: *Roei* conformatis." (This species included under his Sect. 2. Tubericolles "femoribus incrassatis."). Genotype *C. biguttatus* Don. Later authors have included in *Coptocercus*, species having spined elytral apices; indeed, in some species, e.g. *pedator* Pasc. and *nigritulus* Blkb., it is not easy to say whether the apices are more spinose than truncate, the inner spine being absent and the outer angle dentate rather than spinose. The species *undulatus* Hope was included by Hope in his Sect. 1, "armigeri", "Antennis thoraceque spinosis, apicibus elytrorum bidentatis", but it is a true *Coptocercus*, the lateral tubercle of the prothorax being somewhat conical, though not spinose, the femora thickened and pedunculate and the elytra "haud spinosa", which difficulty of classification Hope evaded by an appeal to the imagination—"I imagine, therefore, as the insect is unique and much damaged that probably they" (the apical spines) "have been broken off". Six examples are before me showing a wide distribution: Western Australia, Victoria and Queensland. I should include it under the truncate apex section, two examples showing little exterior production.

I have followed Lacordaire's tabulation of this genus and take the pedunculate femora as the separating character of *Coptocercus* from *Phoracantha*.

C. pubescens Pasc.—I have examples before me from Queensland, New South Wales and South Australia. A cotype of *C. fraternus* Blkb., in the South Australian Museum, is merely a large example of this.

C. pubescens Pasc. Var. 1.—An example sent from the British Museum and another in the South Australian Museum show a pale subapical macula. Var. 2. An example in the latter Museum has the medial pale markings almost obliterated, and showing a small, vague, subapical spot on each elytron.

C. decorus Perroud.—The description of this reads very much like that of *C. biguttatus* Don. with which its author compares it, but the distinctions he gives are scarcely specific and are of the kind that occur throughout the whole group.

C. vicinus Hope is of a pattern very like *biguttatus* Don., but is clearly distinguished by its spinose elytra. I have only seen this from Queensland and Northern New South Wales.

C. assimilis Hope.—The long series of *C. rubripes* Boisd. before me, occurring from New South Wales to Western Australia, link up Hope's species with *rubripes*, of which it is a large form.

Dr. Aurivillius has described and figured three species from Queensland (*Arkiv. for Zool.*, 1916, pp. 5-7). Of these *C. vittatus* Auriv., almost certainly = *C. vicinus* Hope (placed under *Phoracantha* in his catalogue); *C. truncatus* Auriv. seems to be little more than a dark variety of *biguttatus* Don., the frontal structure mentioned being not uncommon in the genus; *C. rugicollis* Auriv. is probably distinct and valid with an unusual prothorax "utrinque in medio leviter convexo nec spinoso nec tuberculato." I think four specimens before me answer the description, two in the British Museum labelled Groote Eylandt and Australia respectively, one in the Queensland Museum from Cape York, and one from Ourimbah, New South Wales, in my own collection. If I am correct in this the elytral pattern is very similar to that of *Phoracantha semipunctata* F., the two pale fasciae being divided by a dark zig-zag band.

C. validus Gah.—This species, described from N.W. Australia, has a wide distribution, though not common in collections, probably being often confused with the common *P. quinaria* Newm., which it closely resembles. I have examples before me from Queensland and New South Wales (Wagga). Two of these (in the Macleay Museum) have the elytral apices subtruncate; in one example the external spine is merely a slight tooth, in the other a rather longer tooth, the internal spine being obsolete in both.

Table of Coptocercus.

1.	Elytral apices truncate	2
	Elytral apices bispinose	6
2.	Apical region of elytra immaculate	*pubescens*
	Apical region of elytra maculate	3
3.	Pale apical macula small and isolated	4
	Pale apical macula large, continuous to apex	5
4.	Ground colour red, medial marking vaguely fasciate	*biguttatus* Don.
	Ground colour fuscous, medial markings, two oblique fasciae connected and widely extended at sides	*undulatus* Hope
5.	17-21 mm. long, elytral pattern near *Ph. semipunctata* F.	*rugicollis* Auriv.
	10 mm. long, elytral pattern near *Ph. quinaria* Newm.	*nigritulus* Blkb.
6.	More than 25 mm. long, form robust, pattern as in *P. quinaria*	*validus* Gahan
	Less than 25 mm. long, form narrower	7
7.	Elytral apices wholly white, this white area connected laterally with medial white fascia	8
	Apical white macula clearly separated from medial fascia	9
8.	Preapical dark marking with straight anterior margin, punctures fine	*crucigerus* Hope

Preapical dark marking angulately produced forward, punctures coarse .... *trimaculatus* Hope
9. Prothorax laterally dentate or spinose ..... *aberrans* Newm.
Prothorax laterally tuberculate 10
10. Apical third of elytra sublaevigate 11
Apical third of elytra clearly punctate ..... *rubripes* Boisd.
11. Ground colour black, or nearly so, apical white macula small ..... *pedator* Pasc.
Ground colour reddish, apical white macula elongate ..... *vicinus* Hope

Synonymy.

(1) *C. crucigerus* Hope = *politus* Pasc. (*Fide* K. G. Blair from examples in the British Museum).

(2) *C. pubescens* Pasc. = *fraternus* Blkb. (Cotype of *fraternus* Blkb. examined).

(3) *C. rubripes* Boisd. = *allapsus* Newm. = *roei* Hope = *assimilis* Hope. The first two already recorded, *assimilis* Hope is added after an examination of long series.

(4) *C. biguttatus* Don. = *decorus* Perr. var. *truncatus* Auriv. (From similarity of description).

(5) *C. trimaculatus* Hope = *savesi* Fauv. (Recorded by C. J. Gahan, *vide* above).

(6) *C. vicinus* Hope = *vittatus* Auriv. (From description and figure of *vittatus* compared with examples compared with type of *vicinus* Hope).

Atesta Pasc.—Genotype *A. balteata* Pasc.—The antennal spines are reduced to a minimum in this genus. The third segment is only feebly spinose, even in *A. tatei* Blkb., the largest recorded species. In *A. dixoni* Oke I can only clearly make out this spine at all in the minority of a fairly long series before me. Pascoe makes the above remark of *Allotisis*, but in my series of the three species I can generally quite clearly discern spines on segments 3-5, though Pascoe's description says "tertio et quarto apice sub-spinosis."

The distinction between *Allotisis* and *Atesta* is not very clear. The only three distinguishing characters of *Allotisis* that can be gleaned from the author are (1) wider head, (2) truncate apices, (3) slender form. (1) is, I think, mythical; (2) has been set aside (I think correctly) in the inclusion of *tatei* Blkb. and *besti* Oke under *Atesta*; (3), however, remains as a good distinction, the species of *Atesta* being more depressed, parallel, and wider; of *Allotisis* more convex, with a narrower more tapering form. There is, moreover, a distinctive elytral pattern, which seems to have some generic value in the Cerambycidae (see also under *Thoris*). I have examined the type of *A. eremita* Blkb. and a cotype of *A. tatei* Blkb., and the following comparison may be helpful:

Atesta tatei.	*A. eremita.*
1. Size larger, colour darker	size smaller, colour paler
2. *Apices of elytra* subtruncate, with suture spinose	rounded
3. *Pronotum* very nitid	subopaque except on nodules
4. *Elytra* with or without premedial pale marking.*	with premedial pale marking
5. *Apical pale mark* not extending to apex.	at apex
6. *Elytral punctures* coarser.	finer

* Blackburn said he had not seen this in any example of *tatei*. It occurs in two out of five examples before me.

ATESTA ANGASI Pasc. var. UNICOLOR, n. var.

Two examples under examination both, I think, males, are wholly dark brown without any elytral pale markings. I can find no structural or even superficial difference in these from the very common *A. angasi* Pasc. The antennae have the third segment with a strong spine at the exterior apex, the other segments are unarmed. The elytral apices are subtruncate with the sutural angle slightly produced. The elytral punctures are largest near the middle, diminishing in size and depth hindward, but traceable to the apex. One example is labelled "Mallee, Victoria" in the National Museum, and is of a dark, nitid brown colour. The other, in the Macleay Museum, is fusco-castaneous, and is labelled "South Australia." (Pascoe omitted any reference to antennal spines in his description of *angasi*).

Dim.—15-19 × 4-5 mm.

Table of Atesta.

1. Apices spinose at suture, with subapical yellow spot; more than 20 mm. long ..... *tatei* Blkb.
   Apices subtruncate (sometimes a little produced at suture), subobsoletely yellow at apex; less than 20 mm. long ..... *angasi* Pasc.
   Apices rounded 2
2. Elytra with post-basal mark yellow, besides medial and apical spot .. *eremita* Blkb.
   Elytra without such post-basal mark 3
3. Pronotum and elytra (predominantly) reddish, elytra sometimes with vague apical pale mark ..... *balteata* Pasc.
   Pronotum and elytra dark, apices more or less widely yellow 4
4. Feebly pubescent, medial fascia wide and straight ..... *bifasciata* Pasc.
   Strongly pubescent, medial fascia narrowed at suture and produced along it anteriorly ..... *dixoni* Oke*

N.B.—Besides those bred by Mr. Dixon from wood brought from Lake Hattah, Victoria, one example before me is labelled "Sydney. N.S.W. (W. Duboulay)" and another, in the Macleay Museum is labelled "Port Denison, Q'land"; a specimen from the British Museum is labelled "Rockhampton (Pascoe Coll.)". I have examined a considerable number of this species and find that the antennal spine, always small, is entirely absent in the ♀ examples examined and is apparently a sexual character, an observation which may possibly need confirmation. I have not been able to include *A. besti* Oke, described from a unique example, since the description is not very lucid, the following note somewhat contradicting the colour description, while the truncate apex does not sufficiently distinguish it, both *angasi* and *dixoni* sometimes showing this.

Table of Allotisis.

1. Apices of elytra without yellow spot ..... *unifasciata* Hope
   Apices of elytra with yellow spot 2
2. Surface subopaque, elytra with two well-marked zig-zag fasciae ..... *scitula* Pasc.
   Surface subnitid, elytral fasciae reduced to spots ..... *discreta* Pasc.

Examples of the only three recorded species are before me, *A. unifasciata* Hope from New South Wales and Victoria being apparently the commonest. *A. discreta* Pasc., I have only from New South Wales and *A. scitula* Pasc., only from Queensland. The last is the genotype.

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* *A. dixoni* is readily distinguishable by its smaller size and the distinct form of the medial fascia, omitted from the description, but present in eleven examples before me.

Subgenus Allotisis Pasc.

The distinction between *Allotisis* and *Coptocercus* only applies to the less developed antennal spines, though in this character they are more marked than in *Atesta*. Pascoe's remark on this (*Proc. Linn. Soc. Lond.*, 1866, p. 99) might well be transferred to *Atesta*.

Thoris Pasc.

Lacordaire considered *Thoris* very slightly differentiated from *Coptocercus*. The distinction from *Allotisis* is even slighter. Blackburn (*Proc. Roy. Soc. Vict.*, 1900, p. 228) suggested that, from their descriptions, *Allotisis* and *Thoris* "may well be synonyms". The very distinct facies of *Thoris* would, I think, deserve its separation, as in the longicorns a special style of marking seems to possess generic value.

Table of Thoris.

Each elytron having 7 eburneous spots ..... *septemguttata* Blkb.
Each elytron having 6 eburneous spots ..... *sexguttata*, n. sp.
Each elytron having 5 eburneous spots ..... *eburifera* Pasc.
Each elytron having 2 eburneous spots ..... *moerens* Blkb.

Thoris sexguttata, n. sp.

Rufo-flavous; each elytron with six eburneous elevations, sparsely pilose. *Head* with distinct medial line; antennae longer than body; segments 3-5 minutely spined on outside; the proportions of segments similar to those of *eburifera* Pasc. *Prothorax* biconstricted, obtusely nodose at sides and quadri-nodose on disc, with a slight, elongate, medial elevation, the depressed areas filled with golden pubescence. *Elytra* rather irregularly, but somewhat coarsely punctate, the punctures larger at sides, smaller and sparser at base, subobsolete at apex; nowhere showing definite seriation; apices subtruncate-dentate, external angles a little acutely produced; the white spots placed as follows: three premedial as in *septemguttata* Blkb., a larger, oval, subapical spot placed obliquely, and two half-way between this and the premedial, placed on a curve parallel to a line drawn through the second and third spots on each. Other characters as in *T. eburifera* Pasc., and *T. septemguttata* Blkb.

Dim.—8 × 2 mm.

Hab.—Queensland (F. P. Dodd).

A single male example is so like *eburifera* that at first I overlooked the difference of number of the white elevations, but an examination of a series of the two species mentioned above shows that the number and position of these are constant; so that the species deserves a specific name.

Holotype in the British Museum.

A second example has been sent from the Melbourne Museum since the above was written.

Porithodes Auriv. (*Cat. Junk*, 1912, p. 94).

Porithodes is distinct from *Porithea*, of which the only recorded Australian species is *P.* (*Callidium*) *intorta* Newm.

In *P. plagiata* Blkb., described erroneously as a *Porithea*, the antennae have segments 3-5 very clearly spined as is also the case in Lea's species. This species

occurs twice in the Junk Catalogue, (1) under *Porithodes*, p. 94, and (2) under *Porithea*, p. 118.

Synonymy.—*P. fasciata* Auriv. = *P.* (*Porithea*) *obliqua* Lea.

Lea's paper was apparently published only one day later than that of Dr. Aurivillius (Results of Mjöberg Expedition), so that *fasciata* gets the benefit of priority. I have specimens of this from Dorrigo and Newport, New South Wales. The figure given by Aurivillius, together with the descriptions, make the synonymy, I think, conclusive.

Porithodes spinipennis, n. sp.

Castaneous; elytra with wide medial fascia and large apical macula testaceous; sparsely pubescent.

Head nearly impunctate, front finely channelled, antennae with segments 3-6 unispinose (remaining segments wanting). *Prothorax* about as wide as long, slightly constricted in front and behind; sides subequally rounded (outline a little irregular, but scarcely nodose), disc with five slight prominences, the medial one elongate. *Scutellum* triangular with rounded sides. *Elytra* not quite three times as long as prothorax, finely subseriately punctate, each with two traceable subcostate impressions; a row of minute pustules on each sutural border throughout and three rows of more widely divided, similar pustules parallel to the former on the subapical dark area; apices sub-bispinose, the exterior spine well developed, the sutural short.

Dim.—17 × 6 mm.

Hab.—Northern Territory: Alligator River (G. F. Hill).

A single example in the South Australian Museum is easily distinguished from all previously described species, though nearest in pattern to *P. fasciata* Auriv., by its spinose apices. The general colour and striation is otherwise similar to this species; but the medial fascia is much wider, extending to both suture and sides; expanding towards sides. The apical mark extends to sides and apex, leaving the suture narrowly castaneous.

Holotype in South Australian Museum.

Four examples, examined later, are in the National Museum, Melbourne, labelled Darwin.

Sisyrium antennale, n. sp.

Very sparsely setose, testaceous; head black, elytra with a wide subapical fascia and two oval maculae infuscate, antennae and tibiae castaneous.

Head without medial line, eyes large and subapproximate; antennae longer than body, finely lineate, scape robust and curved, third segment longer than fourth and having a short spine at its external apex, the rest subequal in length (longer than fourth) and narrowing to apex. *Prothorax* subcylindric, narrower than head, less than half as long as elytra, constricted in front and behind, sides tuberculate, disc with five small tubercles, the middle one elongate. *Elytra* elongate, parallel, considerably wider than prothorax, apices rounded, with moderately large punctures arranged in series, becoming obsolete at apex.

Dim.—7 × 1·5 mm.

Hab.—North Queensland (F. P. Dodd).

A single example in the British Museum differs from *S. ibidionoides* Pasc., in having longer, more slender antennae with the third segment spinose; eyes more approximate, narrower and more cylindric form, and the presence of two infuscate

spots about half-way between the base and the subapical fascia. It is otherwise very like Pascoe's species in colour. It is clearly distinct from *S. fraternum* Blkb., the only species of the genus so far described with spined antennae. The spine is short but distinct.

Holotype in the British Museum.

Sisyrium bifasciatum, n. sp.

(? ♀ of *S. antennale.*)

Differs from the preceding (*antennale*) in the following: 1. Antennal segments without spine, pale yellow in colour and more robust; 2. Eyes more widely separated; 3. Prothorax and elytra slightly wider; 4. The two elytral maculae replaced by a somewhat semi-circular plagia covering the basal area, its arcuate posterior margin coinciding with the position of the maculae of *antennale.*

Dim.—8 × 2 mm.

Hab.—N. Queensland: Townsville (F. P. Dodd).

The possibility of the antennal spine being a sexual character must be considered here, in view of the two pairs of species described in this paper that so nearly approach one another except in this antennal character, also occurring in the same region. This suggestion also agrees with my note on *Atesta dixoni* Oke, *supra.*

Sisyrium apicale, n. sp.

Head, prothorax, apical two-fifths of elytra, legs and basal segments of antennae black, basal three-fifths of elytra orange, with a variably subobsolete, narrow, interrupted, dark fascia about halfway between base and apical fascia; the greater part of antennae and the two apical tarsi castaneous; abdomen infuscate.

Head: eyes rather close above, interspace less than that between an antenna and internal margin of an eye; front, as also the three basal segments of antennae sparsely and coarsely punctate; scape curved and robust, the third segment with a moderate spine on outside (longer than that in *S. antennale*), third longer than fourth, and about equal in length to the fifth and succeeding segments; antennae longer than body. *Prothorax* subcylindric, with anterior and posterior constrictions and with rounded lateral tubercles and four rather large nitid, little-raised nodules of irregular form on disc, the usual medial nodule vague; sparsely dotted with large round punctures, an upright reddish hair arising from each. *Scutellum* linguiform, orange. *Elytra* subparallel, wider than, and about twice as long as, prothorax; apices conjointly rounded; each with about eight rows of uniformly large round punctures, the individual punctures alternating with those in the adjacent rows and continuous to the apex, though smaller here; sparsely clad with upright hairs, these more evident near sides.

Dim.—7 × 1·5 mm.

Hab.—N. Queensland: Townsville (F. P. Dodd).

The combination of black prothorax and legs and the elytral apex entirely black (or blue-black) distinguishes this species, besides the prominent, but short antennal spine. Three examples before me; one, sent me by Mr. F. H. Taylor of the Townsville Institute of Tropical Medicine, forms the holotype; two paratypes in the British Museum.

SISYRIUM TROPICALE, n. sp.
(? ♀ of *S. apicale*).

Very like the preceding, except for the following differences: 1. Antennae not as long as body and slightly stouter than in *apicale*, the third segment without spine; 2. Prothorax rather wider and shorter, infuscate in one example, orange in a second; 3. Elytra slightly wider, without any sign of the subobsolete premedial fascia.

Dim.—6·5 × 1·7 mm. (approx.).

Hab.—N. Queensland: Townsville (F. P. Dodd).

The case is almost exactly analogous with that of *bifasciatum*, the slight colour distinctions being of little specific value. I believe this and *bifasciatum* will be found to be the females of *antennale* and *apicale* respectively.

Two examples (holotype and paratype) in the British Museum.

NOTES ON THE AUSTRALIAN SPECIES OF *MOLOPHILUS* [TIPULIDAE, DIPTERA]. I.

By Charles P. Alexander, Amherst, Massachusetts.
Contribution from the Entomological Laboratory, Massachusetts Agricultural College.
(Communicated by I. M. Mackerras, M.B., Ch.M.)

(Plate v.)

[Read 29th May, 1929.]

In the present article, I wish to discuss the species of the genus *Molophilus* that were described by Skuse in 1889 (Proc. Linn. Soc. N.S.W., (2) 4, 804-814).

This genus, which will undoubtedly be found to be the largest and one of the most involved groups of crane-flies in the Australian fauna, includes a host of usually small, hairy flies that are often very similar to one another in their general appearance. To handle this vast complex of species, it is necessary to separate them into groups, the only feasible basis for such a separation apparently being the structure of the male hypopygium. The wing-venation is remarkably uniform throughout the group, while the antennae, although showing a great range in length and structure in the males of various species, if used as a basis for group separation would tend to divide closely allied form (as *translucens* Skuse, with short antennae, and *filistylus* Alexander, with elongate antennae). The characters upon which the groups herein recognized are based are admittedly artificial, but appear to me to be the most important and constant that are available. The Australian groups so far discovered may be separated by means of the following key:

1. Male hypopygium with only the ventral lobe of the basistyle well-developed 2
   Male hypopygium with either the dorsal lobe (*verticalis* group) or dorsal, ventral and mesal lobes of the basistyle well-developed 4
2. Three dististyles present, the outer (*od*) with a narrow chitinized strip extending basad along the mesal face of the basistyle to opposite the level of the two basal dististyles (*obd, ibd*) ..... *pervagatus* group
   Two dististyles present 3
3. Apex of ventral lobe of basistyle produced into a chitinized beak .. *plagiatus* group
   Apex of ventral lobe of basistyle unarmed ..... *gracilis* group, *ruficollis* subgroup
4. Dorsal, ventral and usually the mesal lobe of the basistyle produced into lobes, the ventral lobe clavate and provided with erect to retrorse setae and abundant setulae ..... *gracilis* group, *gracilis* subgroup
   Only the dorsal lobe of the basistyle produced into a broad lobe that tapers gradually into a spine ..... *verticalis* group

The *pervagatus* group is now known to be represented in Australia and Tasmania by an extensive series of species, but the group has not been found elsewhere. The chief specific characters are to be found in the pattern of the head, wings and legs, and in the details of structure of the male hypopygium.

The outer dististyle (*od*) is often simple, but may be bilobed or even trilobed. The shape and relative proportions of the basal dististyles are of great importance in the separation of allied species.

The *plagiatus* group is very widely distributed, being represented by an abundance of species in New Zealand, Australia, North and South America, and possibly elsewhere in the Old World.

The *gracilis* group is unusually protean and appears to form a number of lesser divisions in various parts of its range. Members of the *ruficollis* subgroup are abundant throughout Australia and Tasmania and are further represented by a few very large species that seem to be most nearly allied to *froggatti* Skuse in the Chilean subregion. Other subdivisions of the *gracilis* group occur in North and South America and in Eurasia.

The *verticalis* group is still known from a single Tasmanian species.

It should be observed that the presence of an enlarged and usually dark-coloured ring, possibly homologous with a similar structure in the Tettigoniidae and Gryllidae (Orthoptera), is found in the males in several of the above groups. This structure was first noted by Skuse and is best indicated in members in the Australian fauna, but is also found in many extra-limital species.

In the genus *Molophilus*, Skuse described fifteen Australian species, all known only from various stations in New South Wales and now known to represent but a very small proportion of the total number in the Commonwealth. Through the great kindness of the late Dr. Eustace W. Ferguson and Dr. Ian Mackerras, I have been able to examine the male hypopygium of all of the species so described by Skuse that were contained in the Macleay collections. The species so represented are *M. annulipes*, *M. canus*, *M. flavonotatus*, *M. froggatti*, *M. gracilis*, *M. longicornis*, *M. lucidipennis*, *M. pervagatus*, *M. pulchripes*, *M. ruficollis* and *M. translucens*. One additional species, *M. femoratus*, represented in the type series only by females, has since been recognized in the male sex in the Tonnoir collections. The only other species in the Macleay series, *M. notatipennis*, is still known only from the unique female type and, since it belongs to a group that includes several very similar forms, it seems doubtful whether the species can be finally determined without a critical comparison with the type. The two additional species of *Molophilus* described by Skuse are preserved in the Australian Museum and are not discussed in this report: *M. montivagus* is still known only from the unique female type taken at Jindabyne, Kosciusko, at 3,000 feet, and its identity may remain in question, even upon comparison with the type. The last species, *M. helmsi*, is not known to the present writer.

The twelve species to be discussed are herewith arranged in their respective groups, as defined above, and will be described in that order.

Molophilus annulipes Skuse.

Skuse, Proc. Linn. Soc. N.S.W., (2) 4, 1889, 809-810.

The types were from Sydney, the Blue Mts., and Hogan's Brush, near Gosford, August to January. Of the specimens in the Macleay collection, five are males, paratype 1 being identical with the holotype, as described herewith. Paratype 2 is a very distinct but similar species that has been described as *M. mackerrasi* Alexander (*Ann. Mag. Nat. Hist.*, (9) 20, 1927, 369-370), the type being from Hogan's Brush, in August. Paratype 3 is different from the type but the hypopygium is in poor condition, the basal dististyle lacking; this may equal the species later described as *M. persimilis* Alexander. An additional male

and female were earlier removed from the type-series by Dr. Ferguson and described as *M. persimilis* Alexander (*Ann. Mag. Nat. Hist.*, (9) 19, 1927, 22-23), these types being from Knapsack Gully, Blue Mts. Thus, of the large original series, only the type and a single paratype male can be safely retained under the name *annulipes*.

The hypopygium of the lectotype may be described and illustrated (Plate v, fig. 1), as follows:

Basistyle with the dorso-lateral lobe terminating in a black acute spine; ventral lobe elongate, the apex relatively narrow, its mesal face produced into an extensive blackened margin, the cephalic portion of which is further produced into a powerful black spine, directed cephalad; ventrad of the blackened portion with a dense group of long erect yellow setae. Outer dististyle long and slender, the blackened tip expanded and bifid, the two arms very unequal, the outer more than twice the length of the inner, sinuous to the acute apex; inner arm short and nearly straight. Basal dististyle a powerful, nearly straight rod that runs out into a long straight spine, just beyond midlength on the mesal edge with a large nearly appressed lateral spine; on the opposite margin of the style and slightly more basad a tiny blackened spine; surface of style at this level with two setigerous punctures. Aedeagus long and straight, in slide mounts extending caudad to opposite two-thirds the length of the basal dististyle.

The species belongs to the *plagiatus* group and has been made the type of a subgroup.

Molophilus flavonotatus Skuse.

Skuse, These Proc., (2) 4, 1889, 810-811.—*Molophilus canus* Skuse, *ibid.*, (2) 4, 1889, 811-812.

The present species is common and widely-distributed in south-eastern Australia and Tasmania. The above synonymy has been established by a comparison of the lectotypes of the two species. In the type series of *flavonotatus* were the lectotype and a paratype male, from Sydney, in September. In the type series of *canus*, the second paratype is identical with the lectotype, but Paratype 1 represents a distinct but allied form that has been described as *M. indivisus* Alexander (*Ann. Mag. Nat. Hist.* (9) 20, 1927, 368-369), the type (according to Skuse) being from Sydney. *M. flavonotatus* is allied to *M. evanidus* Alexander (New Zealand), differing in the dense patch of setae beyond the outer fork of the basal dististyle, in *evanidus* these setae being greatly reduced in number.

The lectotype is described as follows (Plate v, fig. 2):

Male hypopygium with the basistyle relatively long and narrow, the apical beak small, blackened, surrounded by numerous yellow setae. Outer dististyle relatively long and slender, gently curved, the arms short, the inner arm straight, narrowed to the subacute apex. Basal dististyle a long pale blade, widely expanded near midlength, at the level of the dilated portion bearing a conspicuous curved black spine; apical two-fifths of the style more slender, gently curved to the acute tip; before the apex, at the base of the darkened portion, a smaller black lateral spine; mesal face beyond this spine with a dense patch of long yellow setae. Aedeagus long and straight.

The species belongs to the *plagiatus* group, *annulipes* subgroup.

The present records show the following distribution:

New South Wales: Wentworth Falls, Blue Mts., November 18, 1921 (Tonnoir); Sydney, August and September (Skuse); Woy Woy, November, 1921 (Tonnoir).

Tasmania: Burnie, October 25, 1922 (Tonnoir); Geeveston, December 8, 1922 (Tonnoir); Tullah, November 8, 1922 (Tonnoir); Zeehan, January, 1924 (Hardy); Mt. Wellington, November 28, 1922 (Tonnoir); Eaglehawk Neck, Tasman Peninsula, November 17, 1922 (Tonnoir).

Molophilus femoratus Skuse.

Skuse, These Proc., (2) 4, 1889, 805.

The unique type of this species, a female, was taken at Lawson, in the Blue Mts., in January. No additional specimens have been taken excepting a male from Mt. Wilson, Blue Mts., November 19, 1921 (Tonnoir) and a second male at Wentworth Falls, Blue Mts., November 18, 1921 (Tonnoir). This second male is described as allotype, being preserved in the collection of Dr. Tonnoir.

Allotype.—Male. Length about 3 mm.; wing 4·4 mm.

Agrees closely with the female except that the thoracic dorsum is more ochreous-brown than greyish-brown, the median region of the prescutum darker, with very long conspicuous black setae; humeral region brighter. Antennae (male) of moderate length, if bent backward extending about to the base of the halteres; scapal segments ochreous, the flagellar segments darker, fusiform, with a very conspicuous white pubescence and a few scattered dark verticils. Knobs of halteres conspicuously dark brown. Posterior tibiae and tarsi pale yellow. Wings broad, tinged with brown, the veins and macrotrichiae darker, the latter very conspicuous; costal fringe dense.

Male hypopygium (Plate v, fig. 3) with the basistyles elongate, the terminal beak very conspicuous, at apex produced into a strong point that is directed cephalad. Dististyles widely separated, the outer style arising at a point that is nearly opposite midlength of the basal dististyle, relatively small, bifid, one arm directed in a straight line with the axis of the stem and appearing as a spine, the other arm a flattened triangular blade that is directed almost at a right angle. Basal dististyle a very long slender blade, the basal half more dilated, thence narrowed into a long curved apical portion that terminates in a spine; entire outer margin of style with conspicuous spinulae that become larger and more appressed outwardly. Aedeagus relatively long and slender.

The species belongs to the *plagiatus* group.

Molophilus translucens Skuse.

Skuse, These Proc., (2) 4, 1889, 811.

Skuse described this species from a small series taken at Lawson, Blue Mts., and at Gosford and Hogan's Brush, Narara Creek. The lectotype and one paratype male have been examined.

Male hypopygium (Plate v, fig. 4) with the ventral lobe of the basistyle relatively elongate, the apical beak very deep, feebly chitinized, surrounded by numerous setae. Outer dististyle relatively short, bifid, the arms blackened, the inner arm a blunt straight rod, the lateral arm much longer, expanded into a blade, the mesal angle weakly produced. Basal dististyle appearing as a powerful, gently curved blackened rod, the outer or caudal margin with a double row of seven pairs of spines, the basal ones more erect, the outer three becoming progressively reduced in size and more appressed; apex of style relatively short, slender, the extreme tip twisted to one side; base of style more expanded, pale,

on the mesal portion, near the point of darkening with several small elevated punctures, each set with a tiny conical spine. Aedeagus short, less than the basal dististyle.

The species belongs to the *plagiatus* group.

M. translucens is most nearly allied to *M. bipectinatus* Alexander (Victoria, Tasmania), which differs in the slender apex of the basistyle and the more slender basal dististyle, which, beyond the serrations, is prolonged to a curved, acutely pointed spine.

Molophilus longicornis Skuse.

Skuse, These Proc., (2) 4, 1889, 814-815.

The types, a male and female, were taken in August at Berowra and at Knapsack Gully, Blue Mts. Mackerras has designated the male as lectotype.

Male hypopygium (Plate v, fig. 5) with the basistyle relatively long and slender; apical beak relatively slender, chitinized, the tip obtuse, the base surrounded by numerous long setae. Outer dististyle relatively short-stemmed, the arms short and powerful, the outer arm more flattened, the inner arm more slender and nearly straight, the space between the arms narrow. Basal dististyle a long slender horn, gently sinuous, gradually narrowed to the acute darkened tip, longer than the outer dististyle; on outer face just beyond base a small blunt tooth; surface of style on distal third with a linear row of three microscopic spinulae.

The species belongs to the *plagiatus* group.

Molophilus ruficollis Skuse.

Skuse, These Proc., (2) 4, 1889, 804-805.

The type series of six specimens was collected at Lawson, Blue Mts., in January. Through the kind interest of Dr. Mackerras I have been able to examine four type males, including the lectotype.

Male hypopygium (Plate v, fig. 6) with the ninth tergite densely setiferous, the caudal margin pale and smooth. Basistyle produced into a long ventrolateral lobe, the mesal face with abundant erect setae and setulae. Dististyles arising rather close together in the notch of the basistyle; outer style a long slender blade, widened distally, bifid at apex, the inner arm a conspicuous flattened blade, its caudal margin obliquely truncate, the outer arm slender, thumblike, appressed to the inner arm. Basal dististyle a heavily blackened structure of peculiar shape, broadest just beyond midlength, thence suddenly narrowed into an anchor-like apex, the shank stouter than the two slightly unequal arms, the latter acute at tips, the crown of the anchor being further produced into a small knob. Phallosomic structure heavily blackened, rectangular, the apex produced into two curved hooks, the space between with a U-shaped notch. Aedeagus relatively long and slender, in slide mounts extending caudad to shortly before the apex of the ventral lobe of basistyle, its proximal two-thirds subtended by a narrow flattened wing.

The species belongs to the *gracilis* group and has been made the type of a subgroup.

Molophilus lucidipennis Skuse.

Skuse, These Proc., (2) 4, 1889, 813-814.

The types were from the Blue Mts., taken in January. Of the four specimens in the Macleay series, two are males and were mounted and sent to me by Dr. Mackerras. The paratype male proved to be a very distinct species from the lectotype and has been described as *M. forceps* Alexander (*Ann. Mag. Nat. Hist.*, (9) 20, 1927, 37-38). The lectotype is the only specimen in the type series that can safely be referred to *lucidipennis*.

Male hypopygium (Plate v, fig. 7) with the ventral lobe of the basistyle unusually elongate, being approximately as long as the basal portion of the style, the mesal face with abundant erect setae and setulae. Dististyles placed close together in the notch of the basistyle; outer style with a short sinuous stem that soon dilates into a flattened blade, the apex further produced caudad into a long slender gently-curved black spine; outer margin of the flattened blade blackened; blade produced into a small pale lobe opposite its widest point. Inner dististyle a very long, slender, gently sinuous needle-like rod. Aedeagus long and slender, straight, in slide mounts extending caudad to opposite mid-length of the ventral lobe of the basistyle.

Belongs to the *gracilis* group, *ruficollis* subgroup.

Molophilus froggatti Skuse.

Skuse, These Proc., (2) 4, 1889, 807-808.

Skuse knew only the unique type female, taken at Waverley, near Sydney, in October. The species is now well known and has a wide range in south-eastern Australia, as follows:

New South Wales: Brooklana, Eastern Dorrigo, October, November (Heron); Barrington Tops, 5,000 feet, January, 1925 (Mackerras); Blue Mts., January 26, 1922 (Ferguson); Mt. Wilson, Blue Mts., November 19, 1921 (Tonnoir); Wentworth Falls, Blue Mts., November 18, 1921 (Tonnoir); Sydney, November 19, 1922 (Ferguson).

Victoria: Beaconsfield, November 6, 1923 (Hill); Lower Tarwin, November 22, 1925 (Hill).

Tasmania: Burnie, February 1, 1923 (Tonnoir); Cradle Valley, January 12, 26 and 27, 1923 (Tonnoir); Zeehan, February, 1924 (Hardy); Eaglehawk Neck, November 22-23, 1922 (Tonnoir); Geeveston, December 8, 1922 (Tonnoir); Adventure Bay, December 31, 1922 (Tonnoir).

The male sex not having been described is discussed briefly at this time.

Allotype.—Male. Length 7-9 mm.; wing 7-8 mm.

Characters as in the female, differing chiefly in sexual characters. Male hypopygium (Plate v, fig. 8) with the ninth tergite comparatively large, the caudal margin with a broad V-shaped notch, the lateral lobes thus formed projecting caudad as conspicuous ears, the mesal margins of which are obliquely truncated, the tips narrowly obtuse; a conspicuous slender median lobe. Basistyle with the proximal half stout, the ventral lobe narrower but longer than the longest dististyle. Outer dististyle relatively slender, appearing as a gently curved chitinized rod arising from a more enlarged base, the apex bifid, the inner arm narrowly tipped with black. Inner dististyle a very small acutely-pointed horn. Gonapophyses lyriform, each a long slender rod arising from an enlarged base, these rods directed laterad, thence caudad, decussate across the median line, the tips rather suddenly narrowed, blackened, sinuous.

Belongs to the *gracilis* group, *ruficollis* subgroup.

MOLOPHILUS GRACILIS Skuse.

Skuse, These PROC., (2) 4, 1889, 808-809.

The type series in the Macleay collection included six specimens, among which more than a single species may be confused. Dr. Mackerras sent me the hypopygia of the lectotype male and an additional paratype that is identical with the type, as described and figured, except that the lateral spine or thorn of the inner dististyle is bifid at apex. The species is common and wide-spread and seems to show unusual modifications in the details of structure of the male hypopygium.

Male hypopygium (Plate v, fig. 9) with the basistyle profoundly divided, as in the subgroup; dorso-lateral lobe a slender, gently curved spine; mesal lobe slender and nearly straight, with a few scattered setae along its mesal edge, as figured. Outer dististyle slender, gently curved and narrowed to the acute tip, before the terminal spine with a small erect tuberculate spine. Inner dististyle a powerful rod, the apical half narrowed and gently curved, the tip acute or nearly so; on the lateral face a powerful nearly straight thorn-like spine. Aedeagus relatively short, in slide mounts, if bent backward, extending to a short distance beyond the base of the mesal lobe of the basistyle.

Belongs to the *gracilis* group and subgroup.

MOLOPHILUS PERVAGATUS Skuse.

Skuse, These PROC., (2) 4, 1889, 813.

The type series in the Macleay collection included six individuals of both sexes. Of these, the lectotype and first paratype males are undoubtedly conspecific. Paratype 2 is in poor condition and its identity is doubtful.

Male hypopygium (Plate v, fig. 10) with the tergite relatively long and narrow, provided with numerous long setae. Basistyle elongate, the apex of the ventral lobe flattened, with conspicuous yellow setae. Outer dististyle irregularly trifid, the apex being irregularly bilobed, as shown in the sub-figures; before apex on outer margin with a flattened appressed lobe; as usual in the group, this style is adnate to the basistyle. Outer basal dististyle a long slender rod, nearly straight, narrowed gradually to the acute blackened apex. Inner basal dististyle shorter, appearing as a slender flattened blade, the apical third a trifle dilated, provided with a series of about six small acute teeth arranged in a linear series along the outer margin. Aedeagus relatively long and slender, sinuous.

Skuse stated that the species was generally distributed in New South Wales. I have seen material from Wentworth Falls, Blue Mts., November 18, 1921 (Tonnoir) and Waterfall, November, 1921 (Tonnoir).

The species is the type of the *pervagatus* group.

MOLOPHILUS PULCHRIPES Skuse.

Skuse, These PROC., (2) 4, 1889, 812.

Skuse's types, two males, were taken at Sydney in September. Dr. Mackerras sent me the hypopygia of these two specimens and it was found that the paratype was an entirely distinct species from the type, since described as *M. gracillimus* Alexander (*Ann. Mag. Nat. Hist.*, (9) 20, 1927, 356-357). *M. pulchripes* is now known to be well distributed in New South Wales and Victoria, as shown by the following records:

New South Wales: Brooklana, Eastern Dorrigo, May 26, 1928 (Heron); Barrington Tops, 5,000 feet, January, 1925 (Mackerras).

Victoria: Clarkefield, September 27, 1928 (Wilson); Eltham, August 25, 1928 (Wilson); Ringwood, May 5, 1928 (Wilson); Melton, May 27, 1928 (Wilson).

Male hypopygium (Plate v, fig. 11) with the outer dististyle, when viewed laterally, terminating in a stout black lobe. Outer basal dististyle a little longer than the inner, the basal half pale, the apical half blackened, a little dilated, thence narrowed to a long acute point, the dark portion roughened. Inner basal dististyle slender, the apex dilated into a flattened oval head, at the base of this dilated portion on outer margin with a single appressed spine; head with about ten punctures.

Belongs to the *pervagatus* group.

EXPLANATION OF PLATE V.

Male hypopygia of species of *Molophilus*.

Fig. 1.—*Molophilus annulipes* Skuse. (Apex of basistyle further enlarged.)
Fig. 2.—*Molophilus flavonotatus* Skuse. (Apex of basal dististyle further enlarged.)
Fig. 3.—*Molophilus femoratus* Skuse. (Apex of outer dististyle further enlarged.)
Fig. 4.—*Molophilus translucens* Skuse. (Apex of basistyle, and outer dististyle further enlarged.)
Fig. 5.—*Molophilus longicornis* Skuse. (Apex of basistyle, apex of outer dististyle, and basal dististyle further enlarged.)
Fig. 6.—*Molophilus ruficollis* Skuse.
Fig. 7.—*Molophilus lucidipennis* Skuse.
Fig. 8.—*Molophilus froggatti* Skuse. (Apex of outer dististyle, and basal dististyle further enlarged.)
Fig. 9.—*Molophilus gracilis* Skuse. (Mesal lobe of basistyle further enlarged.)
Fig. 10.—*Molophilus pervagatus* Skuse. (Apices of outer dististyle, and apex of inner basal dististyle further enlarged.)
Fig. 11.—*Molophilus pulchripes* Skuse. (Apex of inner basal dististyle further enlarged.)

PAPUAN GRASSES COLLECTED BY L. J. BRASS.

By A. S. Hitchcock, United States Department of Agriculture, Washington, D.C.

(*Communicated by C. T. White.*)

[Read 29th May, 1929.]

[From October, 1925, to June, 1926, Mr. L. J. Brass was occupied on a collecting trip in the Territory of Papua (British New Guinea) on behalf of the Arnold Arboretum. His collections have been entrusted to me for examination and a complete account of them will appear in the *Journal of the Arnold Arboretum*. He paid comparatively little attention to herbaceous plants, but, among other specimens, collected a few interesting grasses. Sheets of all of these were referred to Dr. Hitchcock, for determination. Several proved new records to the Territory and one was apparently previously undescribed. A complete account of the grasses collected (exclusive of the bamboos) is given herewith.—C.T.W.]

Paspalum cartilagineum Presl.—Maclatchie Point, Gulf Division. 1183. Growing in clumps on the beach.

Paspalum orbiculare Forst.—Hula. 521. Growing in damp hollows in the coast sandhills.

Paspalum vaginatum Swartz.—Kerema, Gulf Division. 1229. A beach grass.

Ischaemum digitatum Brongn.—Kerema, Gulf Division. 1213. Growing on the open grasslands near the coast.

Ischaemum muticum L.—Hula. 514. A sand-binding grass growing just above tide mark. Vailala. 1177. Very common on the beaches between Hula and Orokolo Bay. Bomgwina, Eastern Division. 1616. A common beach grass.

Miscanthus japonicus (Thunb.) Anderss.—Ihu, Vailala River. 920. Growing in large thickets on the river banks.

Apluda mutica L.—Hula. 522. A diffuse grass 12-18 inches high, growing in damp places in coast sandhills.

Pogonatherum paniceum (Lam.) Hack.—Budatobara. 768. Growing in wet rock crevices. Kuraudi, Eastern Division. 1391. A small grass growing in crevices of river-bed rocks.

Themeda gigantea (Cav.) Hack.—Bisiatabu, alt. 1500 feet. 634. Tall, coarse grass, 6-8 feet, growing in dry savannah forest country. Kerema, Gulf Division. 1205. In clumps 4-5 feet high on open grasslands near the coast.

Themeda triandra Forsk. Budatobara. 765. A dominant species growing in dry savannah forest country, alt. 300 feet.

Rottboellia ophiuroides Benth.—Budatobara. 776.

Elionurus citreus Munro.—Kuraudi, Eastern Division. 1397. A tall grass in old garden clearings.

Centotheca latifolia (Osbeck.) Trin.—Ihu, Vailala River. 976. Growing in clumps 3 feet high in open places in rain-forest.

Leptaspis urceolata R. Br.—Bisiatabu, alt. 1500 feet. 587. In small clumps on the edge of rain-forest. Ihu, Vailala River. 964. Common in rain-forest floor. Fruits covered with adhesive hooked hairs.

Polytoca macrophylla Benth.—Kerema, Gulf Division. 1203. Tall clump grass 5 feet high growing on open ridges near the coast.

Coix lacryma-jobi L.—Aisa River, Eastern Division. 1417. Tall river-bank grass, 5-6 feet high; fruits glossy grey.

Leptochloa scabra Nees.—Domara River, Eastern Division. 1597. Grass on new plantation clearings.

Leptochloa virgata (L.) Beauv.—Budatobara, alt. 300 feet. 750. A grass 4-5 feet high, growing on river banks. Domara River, Eastern Division. 1599. On new plantation clearings.

Pennisetum macrostachyum Trin.—Loloki River. 538. A tall grass with branching stems to three-quarters of an inch diameter. Growing near river.

Oplismenus hirtellus (L.) Beauv.—Mori River, Eastern Division. 1534. Growing on forest paths.

ISACHNE BRASSII, n. sp.

A slender creeping perennial; culms glabrous, branching at base, decumbent and rooting at the lower nodes, the fertile branches ascending as much as 20 cm. tall; sheaths glabrous, except the pilose margin; the collar minutely pilose; ligule a row of stiff hairs 1 to 2 mm. long; blades narrowly oblong-elliptic; flat, 2 to 5 cm. long, 3 to 5 mm. wide, scabrous on both surfaces; panicle elliptic, 4 to 6 mm. long, open, the branches ascending, 1 to 2 cm. long, the spikelets short-pedicelled along the main branches; spikelets about 1·7 mm. long, obovoid, obtuse, glumes about as long as the spikelet or the first a little shorter, minutely hispid near the summit, the first 5-nerved, the second 7-nerved; florets of equal height, the second very minutely and obscurely pubescent near margin, otherwise glabrous.

Type in U.S. National Herbarium, No. 1385088, collected in swamps, Ihu, Vailala River, Papua, February 20, 1926, by L. J. Brass (No. 1018).

Ledermann's No. 10444, from New Guinea, appears to belong to this species, though it is larger, the culms as much as 50 cm. tall, the blades as much as 8 mm. wide, and the panicles as much as 11 cm. long, the spikelets mostly on branches of the second order.

Panicum pilipes Nees.—Aisa River, Eastern Division, Papua. 1423. Growing on shady forest paths.

NOTE ON A FOSSIL WOOD FROM CENTRAL AUSTRALIA.

By A. B. Walkom, D.Sc.

(Plate vi.)

[Read 29th May, 1929.]

A specimen of petrified wood from the Cretaceous erratic-bearing beds at Muloowurtina in Central Australia (see Woolnough and David, *Quart. Journ. Geol. Soc.*, lxxxii, 1926, 332), though the structure is, on the whole, poorly preserved, shows some features which merit description, especially as so little is known of such woods from this region. The specimen is part of a stem which was at least 13 cm. in diameter.

The pith is made up of polygonal cells, up to 40 μ in diameter, groups of which are thick-walled. The pith is considerably broken and poorly preserved, and was very small. The secondary wood encloses, almost completely, a central area with diameter not exceeding 1·5 cm.; there is no trace preserved of the primary wood. A few of the innermost rows of the tracheids of the secondary wood are smaller than the succeeding rows (Plate vi, fig. 2, A) but these smaller rows are arranged in regular radial series and, it seems, must be regarded as part of the secondary growth.

The secondary wood is moderately well preserved in general, but not in detail. The tracheids are very much thickened (Plate vi, fig. 1), the lumen being frequently reduced to a very small opening; they are usually four- or five-sided, equidimensional, averaging 25-30 μ diameter in the spring wood, and 25-30 $\mu \times$ 10-15 μ in the summer wood, of which there are but few rows. The growth rings are prominent and well preserved and are also narrow; measurements of the width of the rings showed them to vary from 0·3 mm., to 1·5 mm., with an average of about 0·57 mm. The variation may be illustrated by one series of successive rings which, proceeding outwards from the central region, measured approximately as follows: 305 μ, 255 μ, 305 μ, 285 μ, 510 μ, 510 μ, 590 μ, 1,450 μ, 815 μ, 665 μ, 610 μ. It so happens that the widest of the rings on the line measured was expanded just at that point and quickly narrowed to 1,105 μ and 1,020 μ on either side of the line of measurement.

In longitudinal section the imperfection of the preservation is more apparent. On the radial walls of the long and narrow tracheids (25-30 μ wide) are large, circular or somewhat flattened bordered pits (Plate vi, fig. 3). The pits are 12-15 μ in diameter and have a comparatively narrow border; they are usually uniseriate (occasionally there are two opposite pits) and the pits are either separate or slightly in contact. In tangential section the medullary rays are apparently all uniseriate, but few of them are preserved and it is not possible to tell accurately their height; in the few preserved the height is not great, 3 to 15 cells, but they may be still higher.

There is not sufficient detail of structure preserved to warrant even generic identification of the specimen. One can, however, say that it is a coniferous wood, and that it is not Araucarian.

Numerous specimens of fossil wood occur in the Cretaceous erratic-bearing strata from which this specimen was obtained, and it is of interest to consider whether the structure of the wood indicates cold conditions during the period in which the trees grew. The feature on which stress has been laid in this connection is the small width of the growth rings. After a preliminary examination of this specimen from Muloowurtina, Professor A. C. Seward offered the following remarks (see Woolnough and David, *Quart. Journ. Geol. Soc.*, lxxxii, 1926, 344-5): "The wood is no doubt Coniferous, and the rings appear to be fairly well marked. Rings of growth are, I am inclined to think, sometimes overestimated as trustworthy evidence of climate, but those in your specimen may well indicate regular seasonal change. The wood has no indication of Arctic conditions, such as we have in Greenland." To these remarks Woolnough and David (p. 345) added the following observation: "At the same time, it may be mentioned that the rings of growth are narrow, of the order of only about ·05 inch in width, *like those of the dwarf trees of cold climates*" (italics mine). In view of this addition series of measurements were made of the width of growth rings in recent conifers in the late Miss Holden's collection of slides of coniferous woods in the Botany School at Cambridge, with the following results:

	Range in width of rings. mm.	Average width. mm.
Juniperinus communis	0·27 - 1·35	0·7
Taxus brevifolia	0·4 - 0·85	0·6
Araucaria sp.	0·5 - 1·3	0·75
Phyllocladus sp.	0·5 - 1·5	0·9
Tsuga sp.	0·65 - 1·3	0·9
Cretaceous wood (for comparison)	0·3 - 1·5	0·57

In measuring the rings of the recent conifers those nearest the pith were measured so that the comparison with the fossil is a fair one.

It will be seen from the above table, in which the measurements of the Muloowurtina specimen are included for comparison with the recent woods, that the growth rings in the fossil are closely comparable in width with those in a wide range of recent genera, and therefore that it is quite impossible to use this feature as an argument in favour of the existence of Arctic climatic conditions during the growth of the trees. All that may be reasonably concluded is, as Professor Seward stated, that the rings "may well indicate regular seasonal change."

EXPLANATION OF PLATE VI.

Coniferous wood from Muloowurtina.

Fig. 1.—Transverse section, showing well marked growth rings, few rows of summer wood, and extensive thickening of walls of tracheids. (× 40 approx.)

Fig. 2.—Transverse section, showing portion of pith region with only a few cells preserved, and groups of smaller regularly arranged tracheids (A) at inner margin of secondary xylem. (× 60 approx.)

Fig. 3.—Radial longitudinal section, showing single vertical row of pits, somewhat flattened, on the radial walls of the tracheids. (× 60 approx.)

CALCAREOUS CONCRETIONS IN THE UPPER MARINE SERIES, SINGLETON DISTRICT, NEW SOUTH WALES.

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(*Published with the permission of the Under Secretary for Mines.*)

(Plates vii-viii, and two Text-figures.)

[Read 26th June, 1929.]

Introduction.

Concretions of various kinds are found associated with a great variety of sedimentary rocks. As a rule they are regarded as having passing interest only, or at best, as throwing some light upon the conditions under which they and the rocks with which they are associated, were formed, or have been subjected to, since their deposition.

Calcareous concretions are fairly common in the Permo-Carboniferous strata of the Hunter Valley. Reference is made by Professor Sir Edgeworth David to calcareous concretions in both the Lower and Upper Marine Series. The concretions in the former occur between Rothbury and North Rothbury, adjoining the road from Cessnock to Branxton. They contain abundant *Stenopora* and Fenestellidae and do not as a rule exceed eighteen inches in length or four inches in thickness.

The concretions in the Upper Marine Series mentioned by Sir Edgeworth David (1907, p. 90) occur on the Glendonite Horizon about four miles south-west from Mulbring and are described as clayey concretions about the size of an ostrich egg.

Spheroidal concretions about eight inches in diameter occur in the Ulladulla (Upper Marine) mudstones at Warden Head, Ulladulla (I. Brown, 1925, pp. 26-27).

Concretions, possibly corresponding in part with those described on page 150 of this paper, are mentioned by Jones (1927, p. 116) as having been useful in determining the junction between the Crinoidal shales and the overlying coal-measures, to the east of Mulbring.

Concretionary calcareous sandstones are common in the Upper Coal-Measures throughout the Hunter River Valley.

Attention is here directed to the occurrence of calcareous concretions in the topmost stage of the Upper Marine Series—Permian (Permo-Carboniferous) System—which are not only interesting in themselves, but which have proved most useful in geological mapping in the Singleton-Branxton area.

The concretions were first noted by the writer in 1922. During the subsequent six years detailed geological mapping has been carried out in the Hunter River Valley by the Geological Survey of New South Wales, giving ample opportunity for checking and modifying early observations.

Distribution and Mode of Occurrence.

The concretions to which this note refers occur on a horizon in the Crinoidal stage of the Upper Marine series, approximately 250 feet above the top of the Muree stage. Their occurrence on this horizon has been verified over the whole of that part of the Hunter River area, between Singleton and Greta, which is occupied by Crinoidal shales, extending north to the Carboniferous rocks and as far south as portion 132, Parish of Rothbury, County of Northumberland.

The longest axes of the concretions are parallel to the bedding planes of the sediments, the concretions having been involved in the same fold movements as the beds which contain them. They have a tendency to be well developed over a particular area, so that, following the strike of the containing beds, groups of concretions are found along a definite line rather than regularly spaced series of separated lenses.

There are no observable differences in the lithology of the surrounding beds. Indeed, for a considerable distance above and below the concretions, the shale has no textural or lithological variations which may be detected with the naked eye.

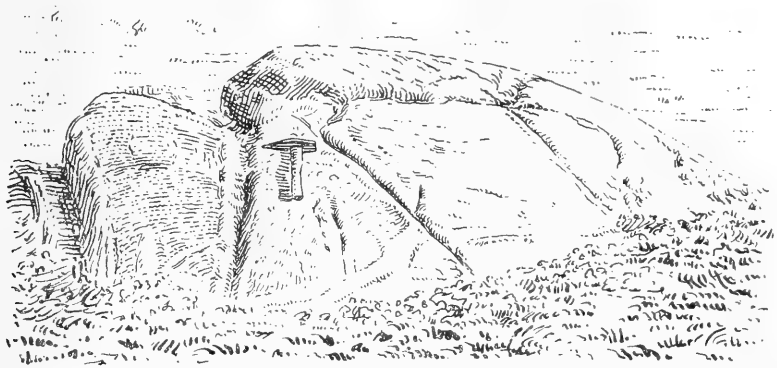
The concretions may be examined in a number of places, notably at Glendon, half-a-mile above Redbournebury Bridge at Singleton and on the main road between Belford and Singleton. Of these, the Glendon exposure is the best (Plate vii, figs. 1, 2). Here are between thirty and forty concretions exposed in the river bank and in the river bed over an area seventeen chains by two chains. Practically all the features mentioned below are to be observed at this locality. In addition it may be noted that the large concretions occur eight to ten feet below the main glendonite horizon on which also small discoid concretions occur, up to eighteen inches in length. The nuclei of many of the latter consist of glendonites. About twenty feet above the glendonites other lenticular concretions, up to three feet in diameter, occur. In the centre of one of these a *Productus* was found, and a group of small pebbles and erratics was noted at the centre of another.

In contrast with the general absence of erratics and pebbles exceeding two inches in diameter, an erratic three feet in diameter was observed to occur between the glendonite horizon and the upper group of concretions. This erratic is hexagonal in plan and consists of amygdaloidal lava, rather like some of the Lower Marine basalts. Another erratic is to be seen adjoining a large concretion. From this concretion, a smaller growth extends towards and is partly bounded by the erratic (Plate viii, fig. 3). The concretion appears to have encountered the erratic in its lateral growth. Close examination of this and other concretions shows little or no tendency for the bedding planes of the shale to be curved over the top of the concretion.

The boundaries of the concretions are sharp and there is no sign of the continuation through them of the bedding planes of the containing sediments. In some places, large pieces of the concretions have fallen away and, on the surfaces so revealed, there is a suggestion of lines of concentric growth. These, possibly, however, are due to conchoidal or sub-conchoidal fracture, though in the majority of instances the fallen blocks are bounded by joint surfaces.

Many of the concretions are traversed by a regular series of vertical to sub-vertical joints (intermittent in some places), some of which are filled with chalcedony. The joints are shown in Plate viii, Figure 4 and Text-figure 1.

The concretions are generally separated from each other, but are joined in some places. A small discoid attachment or extension in the plane of the longest axis occurs fairly commonly.



Text-figure 1.—Concretion on main road between Belford and Whittingham showing system of joints with raised and rounded edges.

In some places other calcareous concretions occur above the main horizon. They are relatively small and sporadic in distribution. In the cliff above the Hunter River at New Freugh (the southermost point of the big meander between Singleton and Glendon) concretions occur on three levels. The dimensions of these do not exceed five feet horizontally by three feet vertically. Similar concretions occur in the river bank near Singleton, and in a railway cutting about two miles north-westerly from Minimbah.

Description of Concretions.

The concretions have not been previously described, though in a paper on glendonites by David, Taylor, Woolnough and Foxall (1909, p. 166) the statement is made that the mudstones forming the bank of the Hunter River, in which the glendonites occur "weather into dome-shaped masses, several feet in diameter". These apparently represented the upper surfaces of the concretions, though they were not described as such, probably because the river had not cut its bed sufficiently deeply to expose them at the time the above paper was written.

The concretions are approximately ellipsoidal masses of a yellow to yellowish-brown colour. The freshly broken material of which they are composed appears in the hand-specimen as a brown rock of uniform texture, which effervesces freely with cold hydrochloric acid. They have an average size of ten feet by eight feet, in plan, by five feet vertically, though fifteen feet by twelve feet by five feet are not uncommon dimensions. The maximum measurements so far noted are eighteen feet by twelve feet by eight feet. The vertical diameter is usually not capable of direct measurement, half the concretion being generally buried in the enclosing shale.

Small pebbles and erratics up to two inches in diameter are sporadically distributed through the concretions. No fossils have been observed to occur in them. The size of the concretions makes it very difficult to examine their central

portions and in no instance has it been practicable to ascertain whether a nucleus of growth or precipitation exists or not. On looking through the literature on the subject, the writer has been unable to find more than one description of concretions which are comparable with those under notice in regard to size and areal distribution. Calcareous concretions at Kettle Point, Ontario, Canada, have been described by Rominger (1873-76) and Daly (1900) and appear to be somewhat similar to those under notice. At the Canadian locality the concretions are nearly spheroidal and do not exceed three feet six inches in diameter, though Daly states that Newberry (1873, p. 155) has recorded a similar concretion ten feet in diameter from Ohio.

In thin section, one of the Glendon concretions is seen to be composed of chips of quartz, plagioclase, orthoclase ?, muscovite, kaolin, magnetite and rock fragments, enclosed in a dominant matrix of finely granular carbonates. The maximum dimensions noted were: plagioclase 0·75 mm., quartz 0·35 mm., a piece of rhyolite 1·00 mm. The outlines of the minerals are sharp and some of the felspar is still fairly fresh. The sharpness of the boundaries of the kaolin suggests that it cannot have been transported as such, but has probably been derived by the alteration of felspar in place. In general the chips are not in contact.

A thin section of a concretion on the Main Northern road between Belford and Whittingham (four miles south of Glendon) shows mainly chips of quartz with some magnetite and very little plagioclase and muscovite. The chips are fairly uniform in size (about 0·05 mm.). The result of a partial analysis of a piece of the same concretion is given in column III in the table below.

The following table also gives the chemical composition of a piece of one of the Glendon concretions, together with that of the shale, from about ten feet above the concretion horizon (David, Taylor, Woolnough and Foxall, 1909, p. 171).

	I. SHALE (Glendon).	II. CONCRETION (Glendon).	III. CONCRETION (Four Miles South of Glendon).
H_2O-	1·35	2·48	—
H_2O+	2·98		
SiO_2	59·66	27·75	38·16
Al_2O_3	12·21	7·51 (*b*)	5·36
Fe_2O_3	1·30	0·70	
FeO	1·80	3·42 (approximate)	—
MgO	1·41	10·46	10·03
CaO	6·55	17·96	17·10
Na_2O	1·69	1·07	—
K_2O	2·26	1·25	—
MnO	0·14	0·26	—
TiO_2	0·68	0·35	—
CO_2	6·08	26·79 (*c*)	24·37 (*d*)
V_2O_5	0·01	—	—
P_2O_5	0·09	—	—
SO_3	2·02	—	0·41
Cl	0·03	—	—
	100·26 (*a*)	100·00	95·43

(*a*) Traces of ZrO_2, Cr_2O_3, BaO and SrO; FeS_2, CoO, NiO proved absent.
(*b*) Includes any P_2O_5 present.
(*c*) By difference. Includes trace of organic matter. Analysed by W. G. Stone (*Ann. Rept. Dept. Mines. N.S.W.*, 1928).
(*d*) Calculated to satisfy CaO and MgO only.

It will be noted that the concretions, though four miles apart, contain very nearly the same percentage of total carbonates and that the lime-magnesia ratio is constant.

Unfortunately an analysis of the shale adjoining the concretions is not available; moreover, the fragment of concretion analysed was not sectioned. Deductions drawn from comparisons between the analyses must therefore be used with caution. It is also necessary to point out that the beds themselves are likely to vary in composition from point to point, more particularly vertically.

The following approximate mineral constitutions may be deduced from the analyses of the Glendon shale and concretion:

	SHALE.	CONCRETION.
Quartz	33·00	11·46
Kaolin	18·26	6·99
Orthoclase	13·34	7·78
Plagioclase	14·15	13·36
Ilmenite	1·37	0·76
Magnetite	1·86	0·73
Siderite	1·04	4·87
Magnesite	2·94	22·01
Calcite	8·90	30·50
Gypsum	3·42	—
Water	1·72	1·54
	100·00	100·00

By the addition of a small amount of muscovite (with corresponding decrease in the kaolin and orthoclase, and increase in quartz) to the above, a fairly close approximation to the mineral constitution of the concretion, as noted in thin section, will be obtained.

On recalculating the analyses to a common base (regarding the alumina as fixed) the concretion shows a gain in lime, magnesia, ferrous oxide and carbon dioxide, and loss of potash and silica.

If the analyses were strictly comparable, carbonation would be distinctly indicated, giving loss of potash on alteration of the felspars and carbonation of magnetite with the production of siderite and ferric oxide. Replacement of some of the silica in the shale would also be implied. Possibly, however, the siderite has been formed by the interaction of a ferrous salt, such as the sulphate, with the production of ferrous carbonate and an insoluble calcium salt such as gypsum. The SO_3 percentage was not determined in the analysis of the Glendon concretion, but as it has been found to amount to only 0·41 per cent. in the other sample, this latter explanation is perhaps not very likely. The apparent defect in silica may be simply the reflection of variation in the quartz content of the sediments.

Time Relationship between Concretions and Containing Sediments.

It is convenient to consider the question of the origin of the concretions from the point of view of time relationship to the enclosing rock. Several authors have suggested classifications based on this factor. Merrill (1906) suggests the terms primary and secondary. A similar two-fold grouping is suggested by Grabau (1913) and Sorby (1908). Richardson (1921) has recently suggested a

three-fold grouping into contemporaneous, pene-contemporaneous and subsequent types.

In this discussion, the terms contemporaneous and subsequent are used with the following meanings: (1) Contemporaneous—formed contemporaneously with the enclosing rock. In this group are included concretions formed at or very close to the surface of a mud (or other sediment) while the muds are still in a very soft watery condition, allowing free access of the overlying liquid. (2) Subsequent—formed by segregating influences acting subsequently to the formation of the enclosing rock. It is apparent that subsequent concretions may be either replacive or displacive.

If the concretions under notice be regarded as subsequent, the materials composing them have to be considered as having been brought in from some outside source or from the surrounding beds. If the former be suggested it is very difficult to explain the deposition of a large amount of calcareous material in masses of rather remarkably uniform size, in a matrix of low permeability. It has been observed already, that there appear to be no lithological differences in the beds on the same horizon as the concretions and those above and below them. If the surrounding beds are considered as having supplied the material forming the concretions the same objections hold, though to a more limited extent.

An elliptical outline in vertical section is sometimes quoted as favouring a subsequent origin (Richardson, 1921, p. 124) and, in general, this will be admitted. Other criteria established experimentally by Richardson cannot be applied here. It must be borne in mind, however, that the Hunter River concretions also diverge from the circle in plan, showing differential growth horizontally, for no apparent reason. It is believed that the conditions stated on page 158 are sufficient to account for the ellipsoidal form of the concretions, assuming a contemporaneous origin.

There seems to be no reason why replacive concretions should be so well developed on a particular horizon in a series which apparently offers equal facilities for their formation throughout its vertical extent. This factor suggests a special environment or set of conditions for the formation of the concretions, which would be most likely to be realized either at the time when the beds were being laid down or after they had been brought into the zone of weathering. The fact that the concretions have been involved in the same folding as the containing beds precludes the possibility of their having been formed since the rocks were brought into the zone of weathering, when solutions could have found a means of circulation by joints and cracks. The uniform total carbonate content in two concretions four miles apart, and the constancy of the ratio of lime to magnesia, seem also to point to uniformity in the conditions controlling deposition, though, of course, further information is desirable.

As pointed out on page 152 an examination of the concretions in thin section shows that little or no replacement of the constituent minerals has taken place. There is also no sign of the silica, which, being in excess in the shale as compared with the concretions, must have been precipitated in the presence of calcium carbonate and carbon dioxide if replacement had taken place (Dean, 1918, p. 413).

The sharply defined boundaries of the concretions, and the absence of any sign of continuation through them of the stratification lines of the matrix are also against replacement. The group of pebbles mentioned on page 150 is regarded by the writer as a composite nucleus. They are only a small fraction

of the lateral axis of the concretion in which they occur and there would probably be some sign of the original bedding in some plane other than that of the longest axis if replacement had taken place.

The question of volume increase is important and appears to dispose of the hypothesis that the concretions may be displacive. The volume increase would vary from 60 to 500 cubic feet for each concretion, or, for the occurrence at Glendon alone, would amount to about 10,000 cubic feet. This factor has to be multiplied many times for all the known occurrences. It has been remarked that it is very doubtful whether any deformation of the overlying beds is present. Marked volume increases of the order mentioned must surely have been reflected in the containing beds if the concretions are displacive.

It is therefore considered that the concretions cannot be displacive and that they are very unlikely to be replacive. The most potent argument in favour of a contemporaneous origin is the fact that the concretions behave as if they were interbedded with the shales. Their occurrence suggests that they owe their origin to a special set of conditions at the time of deposition, to which they owe their form, and that, if these conditions had not existed, a calcareous bed would have been deposited over the area now occupied by the concretions.

Cause of Deposition of the Carbonates.

In seeking an explanation of the mode of formation of the concretions the primary consideration is not shape, but composition. As the analysis shows, they consist of about 53% of the carbonates of calcium and magnesium, together with detrital material. Assuming a contemporaneous origin for the concretions, the latter constituents require no special explanation, since they were being continuously deposited at the time the concretions were formed.

In the following discussion the carbonates of calcium and magnesium will not be regarded separately. The one explanation may apply to both, or the whole of the material may have originally been calcium carbonate, subsequently partially changed by leaching and replacement, a process which proceeds before the final consolidation of sediments and for which there is abundant proof.

A classification (slightly modified) of sediments dominantly calcareous as proposed by Twenhofel (1926) is as follows:

(A) Directly or indirectly due to organic processes.
  (1) Accumulation and cementation of protective and supporting structures of organisms.
  (2) Vital activities of organisms.
    (*a*) Photosynthesis of plants.
    (*b*) Bacterial precipitation.
  (3) Decay of organic matter.
(B) Chemically inorganic processes.
  (1) Changes of condition in water containing calcium carbonate in solution.
  (2) Evaporation.
(C) Mechanically formed.

The following short discussion based on the above table reaches some conclusions which can only be considered tentative. The insufficiency of data on the formation of limestone generally, indeed, precludes the possibility of reaching a thoroughly satisfactory explanation.

The processes given under A1, A2(*a*), B2 and C in the above table are rejected without discussion.

A2(*b*) and A3 are inter-related, since organic matter is generally considered to be necessary for the metabolism of the bacteria responsible for the precipitation of calcium carbonate. It is quite probable that decaying organic matter or bacteria may have initiated the precipitation of calcium carbonate, but these agencies can scarcely have been the principal controlling factors subsequently. In this connection it is necessary to emphasize the fact that the concretions are large and of fairly uniform size, and that they occur on the same horizon over an area of 220 square miles. The concretionary structure implies insufficiency of calcium carbonate available at any one time to form a bed, and their size and distribution indicates the continuation or frequent repetition of this condition over a wide area and throughout a considerable period of time.

It seems most probable that an explanation may be found under the remaining heading B1, namely, changes of condition in water containing calcium carbonate in solution.

It is agreed by a large number of research workers that the waters of the ocean contain large quantities of calcium carbonate. It seems to be generally agreed that the amount held in solution approximates saturation, at least in the warmer seas (Johnston and Williamson, 1916, 734-5). The actual quantity of calcium carbonate held in solution at any one place varies approximately inversely as the temperature (Wells, 1915, 617). The temperature and the amount of carbon dioxide in the air above a body of water together determine the amount of carbon dioxide in the water itself, and upon the latter factor the quantity of calcium carbonate held in solution is largely dependent.

It follows that, if for any reason the amount of carbon dioxide in the atmosphere above a body of water saturated with calcium carbonate is decreased, or the temperature of the water rises, calcium carbonate will tend to be precipitated. Precipitation might also be brought about by agitation of the water liberating carbon dioxide. Applying these considerations to the possible mode of origin of the concretions, we may reject the last-mentioned factor. It seems hardly likely that a variation in the carbon dioxide content of the atmosphere could be assumed, because of the time factor. There remains the controlling influence of temperature.

The concretions would then be satisfactorily explained by precipitation of calcium carbonate during a temporary amelioration of the climate of Upper Marine time or, more probably, in a relatively warm shallow sea. The warming may have been progressive, or the supply of calcium carbonate may have been sustained by the influx of colder water with its higher content of calcium carbonate.

The fact that the concretions occur in groups, rather than in regularly-spaced masses, indicates either variation in the calcium carbonate content of the water, or deposition in shallow water which would experience the maximum warming. Probably both factors operated.

There is a maximum thickness of 1,250 feet of sediments intervening between the concretions and the base of the Upper Coal-Measures. A gradual lessening of cold conditions as the time of deposition of these beds approached is to be expected. It is true that glendonites and erratics occur above the concretions. There is a presumption that cold conditions are necessary for the formation of glendonites, but no proof, as yet. As regards erratics there is a very marked diminution in the abundance of these from the Muree beds upwards. The conditions may be explained by isolation of a shallow sea, with the exclusion of

floating ice, giving relative warmth, followed by the destruction of that isolation and the admission of floating ice and cold water in larger quantities, in a progressively warming climate.

So far as can be ascertained the concretions have not been noted in other areas occupied by Permian rocks. It may readily be supposed, however, that the concretions were formed in a comparatively isolated shallow water area saturated with respect to calcium carbonate, conditions which, possibly, were not exactly repeated elsewhere in the Upper Marine sea. There is also the possibility that the concretions may be represented elsewhere by calcareous masses of smaller size, or by mud beds with a high lime content. There is no lack of these in the Crinoidal Shales elsewhere in the Hunter River Valley. Professor W. R. Browne has drawn my attention to the occurrence of small calcareous concretions around fossils in the Upper Marine Series (top portion) at Wollongong.

There are probably some factors common to the origin of both glendonites and concretions, but the evidence is as yet too incomplete to justify a full statement of a theory of origin. The authors of the paper on glendonites, previously quoted, appear to have established the fact that the glendonites are pseudomorphs after glauberite, but further research is needed to establish the stage in the rock's history when the replacement of the glauberite took place, the chemistry of the reaction, and the relationship existing between the small concretions which enclose many of the glendonites, and the surrounding mudstone.

In accounting satisfactorily for the mode of formation of both concretions and glendonites it should be possible to obtain a pretty clear idea of the environment in which they were formed, and this in turn should have an important bearing on a study of the palaeogeography of the time.

The chalcedony which is found in the joints of some of the concretions has evidently been formed comparatively recently in the rock's history. Professor W. R. Browne suggests that it represents the silica set free by the decomposition of felspar into kaolin. Rastall (1927) states that "silica produced by processes of this class is undoubtedly the source of the deposits of secondary silica which are so common nearly everywhere. . . .". The experimental work of Dean (1918) and his associates shows that a solution of calcium carbonate in the presence of carbon dioxide will cause the precipitation of colloidal silica. Hence, granting the origin of the silica by decomposition of the felspar, the joints in the concretions are ideal places for the formation of chalcedony.

Mode of Formation.

The concretions under notice are particular examples of a fairly general phenomenon and an examination in detail of the cause or causes giving rise to their ellipsoidal form is beyond the scope of this paper. Certain suggestions may, however, be offered. When precipitation from a colloid solution of the emulsoid type takes place, there is, under certain conditions, a marked tendency for the development of a concentric structure.

Scott (1922) states that "amongst the many modes of formation of concretionary structure which have been suggested, that which involves a colloidal origin is most probable." He quotes experimental work (pp. 213-214) as having shown that "concretions form when a substance changes from the emulsoid to the solid state, the structure being radial if the solid is a pure substance, and concentric if the solid is amorphous or in a mixture."

Bucher (1918, p. 603) concluded that "the difference between radial and concentric structure depends on the amount of other substance thrown out simultaneously with and mechanically enmeshed in the growing structure."

It appears quite probable, therefore, that under the conditions postulated in the previous pages, calcium carbonate in solution (or fine suspension) and other materials either in suspension, or in process of deposition, may have been precipitated to form the ellipsoidal concretions, which form the subject of this paper. The subsequent crystalline form of the carbonates would apparently follow, given sufficient time, subtraction of water or increase of pressure. Possibly the cracks noted might also have formed at the time of transition from the colloidal to the crystalline state.

The concretions may be supposed to have begun to grow at the surface of soft muds, and to have continued to grow during burial, enclosing other detrital material at the same time. It is a natural corollary that the process of concentration of a very large number of extremely fine carbonate particles about a nucleus [meaning any centre of precipitation] would be to separate the other materials being deposited, such as pieces of quartz, felspar and rock. These pieces would, therefore, not be in contact as in an ordinary sediment.

There appears to be no reason why the concretions should not have continued to grow for some time after burial in the soft watery muds just below the bottom of the sea. Cessation of growth would ensue with deeper burial, and carbonates would become available for the formation of concretions at higher levels.

The conditions of growth thus postulated would probably be sufficient to induce an ellipsoidal form. The concretions would be, to some extent, displacive, though the surrounding beds, being soft, would not necessarily show signs of movement. This, of course, is quite different from *subsequent* displacement.

Value of Horizon in Geological Mapping.

To estimate the value of the concretion horizon as an aid to geological mapping it is necessary to discuss certain aspects of Permian Stratigraphy.

The Permian System in New South Wales is sub-divided in the Geological Survey Classification as follows:—

Upper Coal-Measure Series.

(*a*) Upper or Newcastle Division.

(*b*) Lower or Tomago Division.

Upper Marine Series.

(*a*) Crinoidal Stage.

(*b*) Muree Stage.

(*c*) Branxton Stage. *Fenestella* shale horizon at 1,550 feet from base.

Lower or Greta Coal-Measure Series.

Lower Marine Series.

(*a*) Farley Stage.

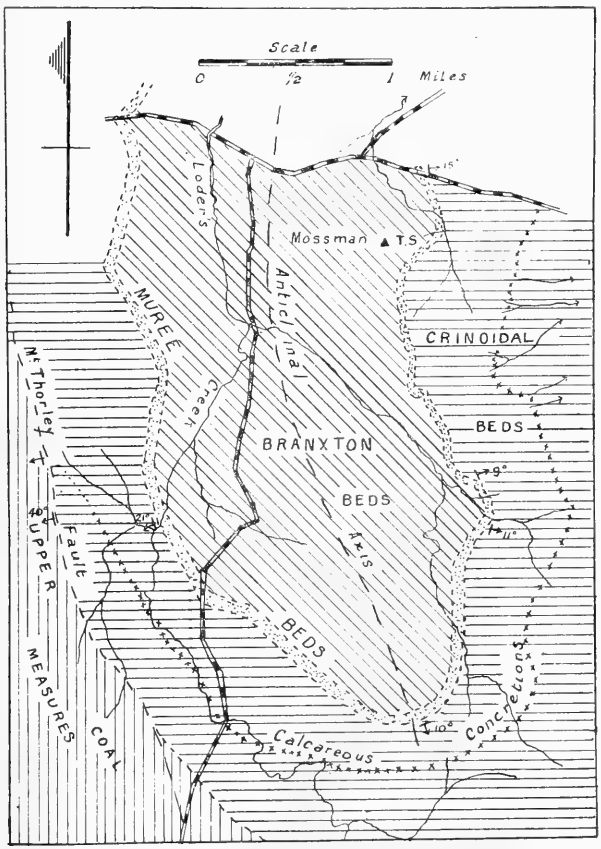
(*b*) Lochinvar Stage.

As already stated, the concretions occur in the Crinoidal Stage about 250 feet above the top of the Muree beds.

Large areas in the Hunter River area are occupied by Upper Marine rocks, and an examination of the structures developed within them has an important bearing on the locating of the underlying Greta Coal-Measures at workable depths. Where exposed the *Fenestella* shales are mapped as the key horizon.

Next in importance are the Muree beds. The latter occur over a much wider area than the former, since denudation following folding has not proceeded sufficiently deeply in many places to expose the *Fenestella* Shales.

The characteristics of the Muree beds in what may be termed the Maitland area are well known through Prof. Sir Edgeworth David's work. Over the greater part of the area described by him this stage consists of massive sandstones containing abundant erratics with the Bolwarra conglomerate at its base, but there are certain well marked changes in its lithology away from this area.



Text-figure 2.—Geological Map of part of Loder Dome (Parishes of Whittingham, Wollombi, and Vere, County Northumberland) showing calcareous concretions in relation to the Muree beds.

As pointed out in the Annual Report of the Department of Mines of 1928 (pp. 111-5) it is necessary to exercise a good deal of caution in identifying the Muree beds in the field. No geologist acquainted only with the Maitland area would recognize the Muree beds as developed round the Loder dome and the southern end of the Belford dome, and prominent beds in the Branxton Stage may easily be mistaken for it. The change is probably due to deposition at

increasing distance from a shore-line. The gradual change in lithology cannot be completely traced, because the more westerly occurrences of the Muree beds limit closed structures. There are thus areas occupied by synclines and basins in which the Muree beds are obscured from view.

In establishing the identity of the Muree beds it is important to note that they are the topmost hard beds in the Upper Marine Series. This criterion alone would suffice in an area in which the whole series was developed and in which the outcrops were good, but where folding and faulting obscure the full details a careful study of the stratigraphy is necessary. As the concretions have been found to occur on a definite horizon 250 feet above the Muree beds, they may be used as a very reliable guide to their identification in the field, in the Singleton district at least.

The concretions also form a ready check in reconnaissance work in delineating the base of the Upper Coal-Measures (*vide* Jones, 1927). They are all the more striking in that they occur in a mud series otherwise largely devoid of features of interest.

Summary and Acknowledgments.

Attention is directed to the occurrence of calcareous concretions having an average size of ten feet by eight feet in plan, by five feet vertically, on a horizon 250 feet above the Muree beds. They have been noted over an area of 220 square miles.

The concretions are considered to have been formed contemporaneously with the enclosing rock in a relatively warm shallow sea subject at times to the influx of cold water. Initiation of precipitation of calcium carbonate may have been due to organic matter or bacteria, but it is considered that the main factor operating to produce continuous deposition about the original centres of growth was the inverse relation which exists between temperature and the solubility of calcite.

The usefulness of the concretions as a means of identifying the Muree beds in the Singleton district is also stressed.

The author desires to record his thanks to the Government Geologist, Mr. E. C. Andrews, for helpful discussion of this paper, to Mr. W. S. Dun, Palaeontologist, for help, freely given at all times, and to Mr. M. Morrison, Geological Surveyor, for facilities afforded by him during the progress of the geological survey of the Northern Coalfield. He also gratefully acknowledges the assistance given him by Assistant-Professor W. R. Browne on many points, particularly in regard to the petrological and chemical discussion, and to other matters, some of which are specified in their appropriate place in the text.

Mr. F. W. Booker, B.Sc., has also rendered the author material assistance in the field, both by discussion and the taking of photographs.

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DESCRIPTION OF PLATES VII-VIII.

Plate vii.

Fig. 1.—Hunter River at Glendon. Alluvium overlying Crinoidal Shale at top left. Glendonites and small concretion horizon immediately below bench in shale. Concretions are shown dipping westerly towards viewpoint.

Fig. 2.—Photograph at same locality as Figure 1 indicating size of concretions.

Plate viii.

Fig. 3.—Concretion in vertical face of shale at Glendon, showing growth towards and partial inclusion of a large glacial erratic (at left).

Fig. 4.—Concretion on stock route from Abbey Green to Minimbah, portion 44, Parish of Whittingham. The concretion occurs on the eastern limb of the Loder dome, the dip being from the higher figure to the lower. The size of the concretion is about 16 feet × 14 feet × 8 feet. Note the system of joints.

Nos. 1, 3 and 4 photographed by Mr. F. W. Booker, B.Sc.; No. 2 by the Author.

NOTES ON THE CEROPLATINAE, WITH DESCRIPTIONS OF NEW AUSTRALIAN SPECIES (DIPTERA, MYCETOPHILIDAE).

By F. W. Edwards.

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(Communicated by I. M. Mackerras, B.Sc., M.B., Ch.M.)

(Four Text-figures.)

[Read 26th June, 1929.]

In these Proceedings (Vol. 53, 1928, 598) Mr. J. R. Malloch has a paper ("Notes on Australian Diptera", xvii) in which he purports to give a generic revision of the subfamily Ceroplatinae. His paper contains some valuable new suggestions for the classification of the group, but it is unfortunate that the author made no attempt to make himself acquainted with the literature published in the twenty years which have elapsed since Johannsen revised the Mycetophilidae in the "Genera Insectorum"; he was apparently unaware* of the fact that I had revised the genera of this family in 1925 (*Trans. Ent. Soc. London*, pp. 505-670), and that Tonnoir and I had together revised the New Zealand species in 1927 (*Trans. N.Z. Inst.*, vol. 57, pp. 747-878). This being the case it is natural that Malloch's work requires some emendation, and in calling attention to the corrections which are required, I should like to take the opportunity of publishing the results of work which I have done on the group since 1925. The publication of Malloch's paper has stimulated me to complete this work sooner than I should otherwise have done, and I am indebted to him on that account.

Apart from the fact that certain recently described genera are omitted, the chief fault in Malloch's key lies in the inclusion as separate genera of *Arctoneura*, *Nervijuncta* and *Casa*. As Tonnoir and I have shown, these belong to the subfamily Ditomyiinae, *Arctoneura* and *Casa* falling as synonyms of *Nervijuncta*. The generic keys published by me in 1925 will hold good in the main, but require amplification in regard to the *Platyura* and *Ceroplatus* groups, as explained below. The distinctions I gave between the Macrocerinae and Ceroplatinae require some modification. The presence of long anepisternal hairs is not constant in the former subfamily, and, as shown by Malloch, short hairs are often present in this position in the Ceroplatinae, a fact which I had previously overlooked. Perhaps the best distinction is that in the Macrocerinae the two spurs of the posterior tibiae are always short and subequal, whereas in the Ceroplatinae one spur is always several times longer than the tibial diameter. A few true Macrocerinae have short antennae. Further, I consider that the genus *Arachnocampa* belongs rightly to the Ceroplatinae and not to the Bolitophilinae, where it was placed by Tonnoir and myself in 1927.

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* In a paper (These Proceedings, 1929) which was in the Press when this paper was received, Mr. Malloch corrects certain errors which had arisen through his not having seen previous papers by Edwards, and Edwards and Tonnoir.—Ed.

PLATYURA Mg.

When revising the family Mycetophilidae in 1925 I introduced new generic names for some aberrant groups of *Platyura*, restricted the old genus to species of the *fasciata* group, with a bristly postnotum (mediotergite), and adopted Brunetti's name *Isoneuromyia* for the remainder, recognizing that this last group was heterogeneous and would require further division. Further study since 1925 convinced me that a rather large number of small groups existed within the genus *Platyura*, which it would be more convenient to treat as subgenera than as full genera, and consequently Tonnoir and I decided, when reviewing the New Zealand species, to revert to the wider use of the name *Platyura*, leaving aside for the moment the question of subgeneric division.

Malloch in his recent paper made use of several of the characters which I had already noted in 1925, and also called attention to another—the presence of hairs on the lower frons—which is very useful in defining one group. It is only just to state that my discovery of some of these characters, and similar characters which are now widely adopted for the classification of the Culicidae, was largely due to hints given by Malloch in his papers on the Anthomyiidae. After examining all the available material, representing approximately one hundred species, I have come to the conclusion that the characters to which both Malloch and I attached first importance—the presence of hairs or bristles on the postnotal pleurotergites and mediotergite, and the position of the vein R_4—are of less taxonomic value than some others, such as the arrangement of the minute setulae of the tibiae and the presence or absence of rows of very small macrotrichia on the branches of the media and cubitus.

Using this last character as a main division, and the other characters previously noted for subdivisions, I am able at present to recognize nineteen subgenera of *Platyura* in the wide sense. Many, if not most, of these are very clearly defined and would by many students be treated as full genera without hesitation, especially if they happened to be Cyclorrhapha. I believe, however, that it will be more convenient to use the name *Platyura* in a comprehensive sense to include all members of the Ceroplatinae which possess the following combination of characters:

Palpi incurved, slender, of three distinct segments. Labium well preserved, but always shorter than head, labella large. Antennae 16-segmented, shorter than body, cylindrical or somewhat flattened, not broadly flattened (as in *Ceroplatus*) nor pectinate (as in *Platyroptilon*). Tarsi and usually tibiae with small spiny bristles; no empodia; hind tibia with outer and inner apical combs, and at least one long spur. Wings without macrotrichia on membrane; media and radius fused for a shorter or longer distance; no trace of fold-like basal portion of media.

Of the nineteen subgenera only four occur in New Zealand; these four and three others have been found in Australia, but several more should occur in that continent.

Key to known subgenera of Platyura.*

1. Branches of media and cubitus with close-set setulae (very small, but visible under an amplification of 80); R_4 always before mid-way between tips of R_1 and R_5; outer spur of posterior tibiae always well developed; pleuro-tergites always bare 2

Branches of media and cubitus bare 7

* The characters mentioned in this key are not repeated in the notes which follow.

2. Tibial setulae in regular rows throughout, all rows alike; costa scarcely produced beyond tip of R_5; *An* strong and almost or quite reaching margin close to tip of Cu_2; mesonotum nearly always uniformly setulose, without bare stripes; mediotergite, hypopleurite and anepisternite bare; no spiracular hairs ..... *Isoneuromyia* Brun.
Tibial setulae irregular, except sometimes towards tip of tibia; costa always produced well beyond tip of R_5; mesonotum (except sometimes in *Neoplatyura*) with conspicuous bare stripes between the double or treble rows of acrostichal and dorsocentral bristles 3

3. A row of erect black hairs immediately behind prothoracic spiracle; mediotergite bare; length of *An* variable ..... *Neoplatyura* Mall.
No spiracular hairs 4

4. All veins reaching margin; mediotergite bare 5
Vein *An* abbreviated 6

5. Hypopleurite with a patch of short decumbent hair; anepisternite hairy above ..... *Pyrtaula*, n. subg.
Hypopleurite bare; anepisternite less hairy or bare ..... *Urytalpa*, n. subg.

6. Postnotal mediotergite with a transverse row of bristles near apex; costa reaching nearly to M_1 ..... *Rypatula*, n. subg.
Postnotal mediotergite bare; costa shorter ..... *Pyratula*, n. subg.

7. Tibial setulae irregular at base, in regular rows on about apical half of tibia; *An* reaching margin, but M_3 and Cu_1 somewhat abbreviated or faint apically; R_4 usually ending near R_1; outer spur of posterior tibiae well developed; mesonotum uniformly setulose; no spiracular hairs; pleurotergite and mediotergite bare 8
Tibial setulae in regular rows throughout (except sometimes at extreme base, and, in *Lutarpya*, on under side of hind tibia); *An* not reaching margin, other veins complete 9

8. A few short erect black hairs on lower frons immediately above and between roots of antennae ..... *Xenoplatyura* Mall.
No such hairs present ..... *Truplaya*, n. subg.

9. All rows of tibial setulae alike 10
About six rows of tibial setulae much more close-set than the others, appearing as conspicuous black lines under a hand lens; mesonotum uniformly setulose; pleurotergite and anepisternite bare; no spiracular hairs; R_4 short, placed at or beyond midway between tips of R_1 and R_5 18

10. Erect dark hairs present on posterior margin of prothoracic spiracle; pleurotergite bare, mediotergite more or less bristly or pubescent; anepisternite and hypopleurite usually with a few short hairs; hind tibia with small dorsal and external bristles as usual; mesonotum uniformly setulose (except sometimes in *Ralytupa*) 11
No spiracular hairs 13

11. Costa reaching well beyond tip of R_5; mediotergite with a few bristly hairs at apex only; outer spur of hind tibiae present but minute, not a quarter as long as inner; no hairs in *front* of prothoracic spiracle ..... *Rutylapa*, n. subg.
Costa reaching scarcely beyond tip of R_5; mediotergite with short decumbent hair 12

12. Outer spur of posterior tibiae well developed; mediotergite pubescent at sides towards base; no hairs in *front* of prothoracic spiracle ..... *Ralytupa*, n. subg.
Each tibia with a single spur; mediotergite pubescent above; erect hairs present in front of, as well as behind prothoracic spiracle ..... *Taulyrpa*, n. subg.

13. Each tibia with a single spur; tibial bristles reduced to a few, postero-ventral in position, on hind tibia and sometimes also on mid tibia 14
Outer spur of posterior tibiae present, though usually very short; at least a few anterior and dorsal bristles on hind tibiae; mesonotum uniformly setulose; mediotergite bare 16

14. Mediotergite bristly above; mesonotum uniformly setulose; *An* and Sc_2 absent; R_4 short, ending beyond half-way between R_1 and R_5; pleurotergites and anepisternites bare ..... *Laurypta*, n. subg.
Mediotergite bare; mesonotum with bare stripes; *An* and Sc_2 more or less indicated 15

15. Pleurotergites with longish erect hair; anepisternite with short hair above; R_4 ending in costa not far from R_1; *An* almost reaching margin ..... *Monocentrota* Edw.
Pleurotergites and anepisternite bare; R_4 ending in R_1; *An* very short ..... *Micrapemon* Edw.
16. Pleurotergites with longish erect hair; anepisternite with short hair above; antennae flattened; wings pictured ..... *Proceroplatus* Edw.
Pleurotergites without long hair; anepisternite bare; antennae cylindrical; wings plain 17
17. Pleurotergites and prosternum with short decumbent dark hair; anepisternite and hypopleurite bare ..... *Lutarpya*, n. subg.
Pleurotergites with very short, dense, erect, pale pile; anepisternite and hypopleurite with small patches of fine hairs ..... *Lapyruta*, n. subg.
18. Mediotergite rather pointed and bristly at apex; three ocelli; *An* moderately long; Sc distinct; antennal pubescence short as usual ..... *Platyura*, s. str.
Mediotergite almost or quite bare; two ocelli; *An* hardly distinguishable; Sc faint apically; antennal pubescence rather long ..... *Tylparua*, n. subg.

In the above key I have purposely mentioned only those characters which are common to the two sexes, but in the male hypopygium there are many important features which may be used to supplement the subgeneric diagnosis as given above. There are two main types of abdominal structure in male *Platyura*, in the first of which it is possible to recognize several subsidiary types, as outlined below:

A. Eighth segment small and more or less retracted within the seventh; seventh frequently small and sometimes retracted within the sixth; hypopygium capable of rotary movement; aedeagus small, lying entirely within the ninth segment and often feebly chitinized; abdomen usually more or less depressed.

(*a*) Ninth tergite small, broader than long; coxites (side-pieces) large; styles (claspers) large, simple, ending in two large teeth: *Isoneuromyia, Pyrtaula.*

This type of hypopygium is identical with that which occurs in the genera *Macrocera* and *Apemon* and evidently represents the primitive type of the subfamily. It will be noted that the two subgenera of *Platyura* included here also retain other primitive features, such as the setose media and cubitus and the complete anal vein.

(*b*) Ninth tergite longer than broad; coxites large; styles simple, but not formed as above, usually with a subterminal tooth: *Pyratula, Rypatula.*

(*c*) Ninth tergite usually large; coxites more or less fused; styles variously formed but usually divided or lobed and never shaped as in the two above-defined groups: *Proceroplatus; Monocentrota; Micrapemon; Lutarpya; Latyrupa; Ralytupa; Rutylapa; Laurypta; Platyura; Tylparua.*

It is probable that distinguishing characters of subgeneric value occur in the hypopygium of some at least of the above groups, but a detailed study will be needed to reveal them, especially as great differences are found between closely allied species.

B. Eighth segment not entirely retracted, often quite large; seventh segment as large as sixth; hypopygium non-rotatable; aedeagus large, strongly chitinized, with apodemes extending back at least into the eighth, often into the seventh or even the sixth segment; coxites and styles always small, the latter especially so, though often of rather complicated structure; abdomen seldom depressed, more often conspicuously compressed apically: *Neoplatyura; Urytalpa; Xenoplatyura; Truplaya.*

Subgenus Isoneuromyia Brun.

Mesonotum uniformly setulose (rarely traces occur of two bare lines, but even so the acrostichal bristles are short and in about four rows). Scutellum usually with short hairs dorsally, in addition to the ordinary marginal bristles. Pleurotergite bare, but usually with a silvery sheen due to microscopic pubescence, and unusually large and sharply prominent, covering base of halteres. Anepisternite and hypopleurite bare. Propleural bristles unusually numerous and strong, most of them projecting downwards in a tuft. Venation: R_4 ending near tip of R_1; M_2 and Cu_1 usually stopping short a little before margin. The species are all of large size and most have conspicuous wing-markings and banded abdomen. In some the antennae are more or less flattened, approaching the structure of *Ceroplatus*.

Genotype, *I. annandalei* Brun. (India).

Additional species: *I. rufescens* Brun. and *Platyura grandis* Brun. (India); *P. magna* Walk. (Australia); *P. novae-zealandiae* Tonn. (*magna* Marsh.) and *P. harrisi* Tonn. (New Zealand); *P. elegantula* Will. (West Indies); and *P. semirufa* Mg. (Europe).

Subgenus Pyrtaula, nov.

Scutellum with marginal bristles only. Pleurotergite not very prominent, rounded behind, without the sharp edge characteristic of *Isoneuromyia*, and without distinct silvery dusting. Propleural bristles few in number, slender and suberect as usual. *An* not very strong, curved, ending some distance from tip of Cu_2.

Genotype, *Platyura agricolae* Marshall (New Zealand).

Additional species: *P. fenestralis* Skuse and *P. venusta* Skuse (Australia); *P. maculipennis* Tonn., *P. rutila* Edw., *P. campbelli* Tonn., *P. ruficauda* Tonn., *P. curtisi* Edw., *P. rufipectus* Tonn., *P. ohakunensis* Edw., *P. punctifusa* Edw., and probably *P. philpotti* Tonn., *P. carbonaria* Tonn., and *P. chiltoni* Tonn. (New Zealand); also a number of undescribed species in the British Museum from South Chile.

Platyura (Pyrtaula) flavipennis, n. nom.

Platyura venusta Skuse 1888, *nec* Walker 1856.

This species is distinguished from *P. fenestralis* Skuse and the allied new species described below, by its somewhat larger size, the strong yellow tint of the wings, and somewhat different wing-markings, especially the brown cloud along lower margin of Cu_2 in outer half of cell Cu_2. The British Museum possesses a ♀ from Burpengary, Queensland (Bancroft).

Platyura (Pyrtaula) westralis, n. sp.

Differs from *P. (P.) fenestralis* Skuse as follows: Size somewhat smaller (wing-length of ♂ 3·5 mm.); scape of antennae clearer ochreous; first abdominal segment entirely ochreous; no darkening on base of Rs; central wing-spot not nearly reaching tip of R_1; no spot below R_4; scarcely a trace of darkening on hind margin of wing between tips of Cu_2 and *An*.

Loc.—Western Australia: Swan River (J. Clark); type and one other ♂ in British Museum. Specimens of *P. fenestralis* Skuse are available for comparison from Melbourne (Hill) and Mangalore, Tasmania (White).

Subgenus PYRATULA, nov.

This subgenus is proposed for two or three species which are certainly related to the subgenus *Pyrtaula*, but are separated therefrom on account of the abbreviated anal vein. All are of very small size and black in colour.

Genotype, *Platyura zonata* Zett. (Europe).

Additional species: *P. perpusilla* Edw. (Britain) and probably *P. minuta* Senior-White (Ceylon) (but this last may belong to the genus *Burmacrocera* Coq.; the type is fragmentary).

Subgenus RYPATULA, nov.

Genotype, *Platyura brevis* Tonn. (New Zealand).

Additional species: *P. subbrevis* Tonn. (New Zealand); and most probably *Platyura gracilis* Skuse (Australia). All the species are of small size, without definite ornamentation, and the subgenus appears to be the antipodal representative of *Pyratula*. The presence of bristles on the mediotergite does not indicate any close affinity with *Laurypta*, *Rutylapa* and *Platyura* (s.str.), which also possess such bristles.

Subgenus NEOPLATYURA Mall.

Genotype, *Platyura setiger* Joh. (N. America).

Additional species: *P. flava* Macq., *P. modesta* Winn., *P. nigricauda* Strobl., and *P. biumbrata* Edw. (Europe); *P. axillariger* End. (Seychelles); *P. tjibodensis* Edw. (Java); *P. ignobilis* Will. (West Indies); *P. mendosa* Lw. (N. America); *P. richmondensis* Skuse and probably *P. monticola* Skuse (Australia); *P. marshalli* Tonn., *P. proxima* Tonn., *P. lamellata* Tonn. and *P. brookesi* Edw. (New Zealand); also the two Tasmanian species described below.

The species are all small, usually yellowish, without conspicuous ornamentation; anepisternite and hypopleurite bare.

The New Zealand species form a somewhat aberrant group in which the mesonotum is uniformly setulose, and vein *An* is more abbreviated than usual, but there seems insufficient reason to separate them subgenerically. *P. monticola* Skuse may belong to this New Zealand group. Among the remaining species there are several rather distinct types of hypopygial structure, especially as regards the form of the ninth tergite (when this is present). Two of these types are represented in the two new species described below.

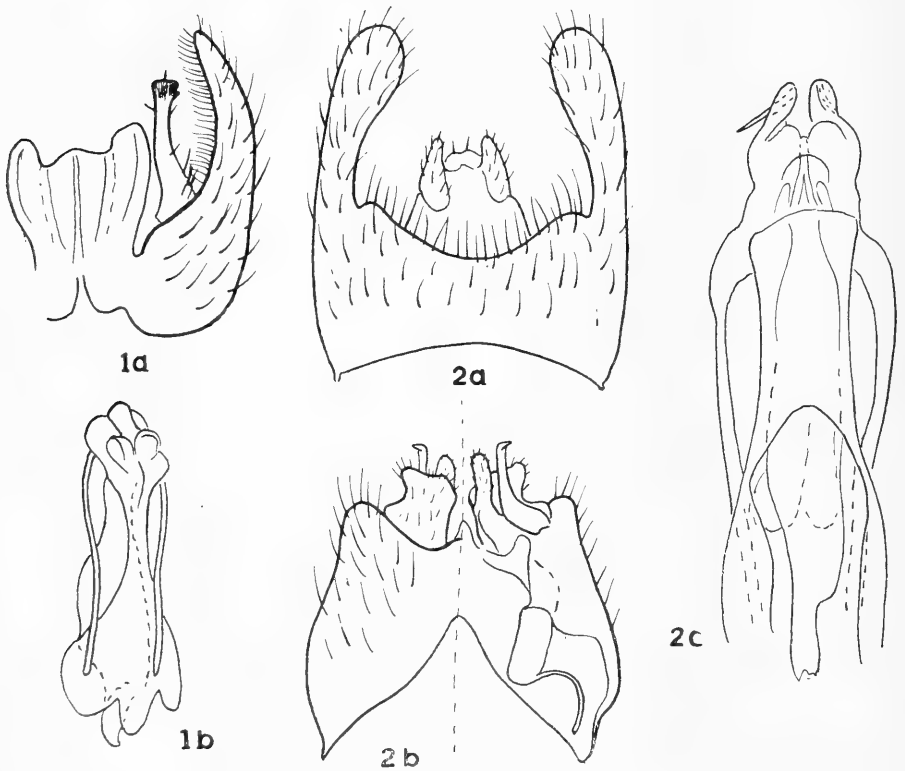
PLATYURA (NEOPLATYURA) FIDELIS, n. sp. Text-fig. 1.

♂. Head black, including antennae and mouth-parts. Antennae as long as head and thorax together, rather stout, flagellar segments somewhat longer than broad. Thorax brownish-ochreous; mesonotum somewhat darker, dull, without definite stripes; anepisternite darker than remainder of pleurae. Acrostichal bristles in a double row as usual. Abdomen dark brownish, hind margins of tergites ochreous, also most of sternites. Hypopygium (Text-fig. 1) with ninth tergite absent or reduced to a very narrow bare transverse stripe; median membranous area of ninth sternite longitudinally folded; coxites densely pubescent within; styles articulated at base of coxites. Legs yellowish. Wings with a faint brown tinge; a faint grey cloud below tip of costa. Sc ending before base of Rs; R_4 only a little before mid-way between R_1 and R_5; costa reaching nearly half-way to M_1; radio-medial fusion very short; *An* extending quite four-fifths

of the way across the anal field. Halteres with ochreous stem, knob darkened. Wing-length 4 mm.

Loc.—Tasmania: Mangalore, 8.xii.1913 (A. White); type ♂ in British Museum.

This belongs to the same group as the European *P. flava* Mcq., *P. modesta* Winn. and *P. nigricauda* Strobl, which likewise have no ninth tergite; the Tasmanian species differs from the European in small details of hypopygial structure, and more obviously in the somewhat abbreviated anal vein.



Text-fig. 1.—*Platyura* (*Neoplatyura*) *fidelis*, n. sp. *a*, ninth sternite, coxite and style from beneath; *b*, aedeagus, half side view.

Text-fig. 2.—*Platyura* (*Neoplatyura*) *tasmanica*, n. sp. *a*, ninth tergite and anal segment from above; *b*, ninth sternite and appendages, left from below, right from above; *c*, aedeagus (proximal portion of apodemes cut off).

All figures to same scale.

PLATYURA (NEOPLATYURA) TASMANICA, n. sp. Text-fig. 2.

♂. Superficially resembles the preceding, differing as follows: Antennae slightly shorter. Palpi dark brownish. Pleurae and postnotum wholly blackish. Hypopygium (Text-fig. 2) with ninth tergite well developed, narrow in middle, with long and rather broad lateral arms; ninth sternite without extensive membranous median area; aedeagus very large. Hind femora with a dark streak

at base beneath. Wings with a larger grey cloud towards costa at tip, reaching back almost to R_4; Sc ending above base of Rs; R_4 before one-third of the distance from R_1 to R_5; costa reaching about one-third of the distance from R_5 to M_1; *An* reaching about three-quarters of the way across anal field. Halteres chiefly pale. Wing-length 4·2 mm.

Loc.—Tasmania: Mangalore, 1.x.1914 (A. White). Type ♂ in British Museum.

The hypopygium somewhat resembles that of the North American *P. mendosa* Lw. It is just possible that this may be *P. monticola* Skuse, described from caves in the Blue Mts.

PLATYURA (NEOPLATYURA) RICHMONDENSIS Skuse. Text-fig. 3.

The British Museum possesses a male of this species from Queensland (Bancroft). It is an almost typical *Neoplatyura*, the only unusual features being the spot over R_4 and the short anal vein. The hypopygium (Text-fig. 3) is interesting, as the form of the ninth tergite is intermediate between *P. tasmanica* and the New Zealand species, the lateral being slender. The bare lines on the mesonotum are also less evident than in *P. tasmanica*, indicating an approach to the type of *P. marshalli*.

Subgenus URYTALPA, nov.

Genotype, *Platyura ochracea* Mg. (*dorsalis* Staeg.) (Europe).

Additional species: *P. atriceps* Edw., *P. macrocera* Edw. (Britain), and probably *P. vicina* Brun. (India).

This subgenus is proposed for a few species which have almost all the external characters of *Pyrtaula*, but in which the hypopygium is totally different from that of *Pyrtaula* and resembles that of *Neoplatyura*. The only external distinction from *Pyrtaula* which I have been able to discover is the absence of minute hairs on the hypopleurite, but it is doubtful if even this is constant. In the genotype (*P. ochracea*) a few small anepisternal hairs may be present or absent.

Subgenus XENOPLATYURA Mall.

Genotype, *Platyura conformis* Skuse.

Additional species: *P. schineri* Skuse and probably *P. contingens* Skuse (Australia); *P. hopkinsi* Edw. (Samoa); *P. octosegmentata* Brun., *P. longifurcata* Brun., and *P. lunifrons* White (India); *P. longejuncta* Speiser (W. Africa); and several undescribed African species in British Museum.

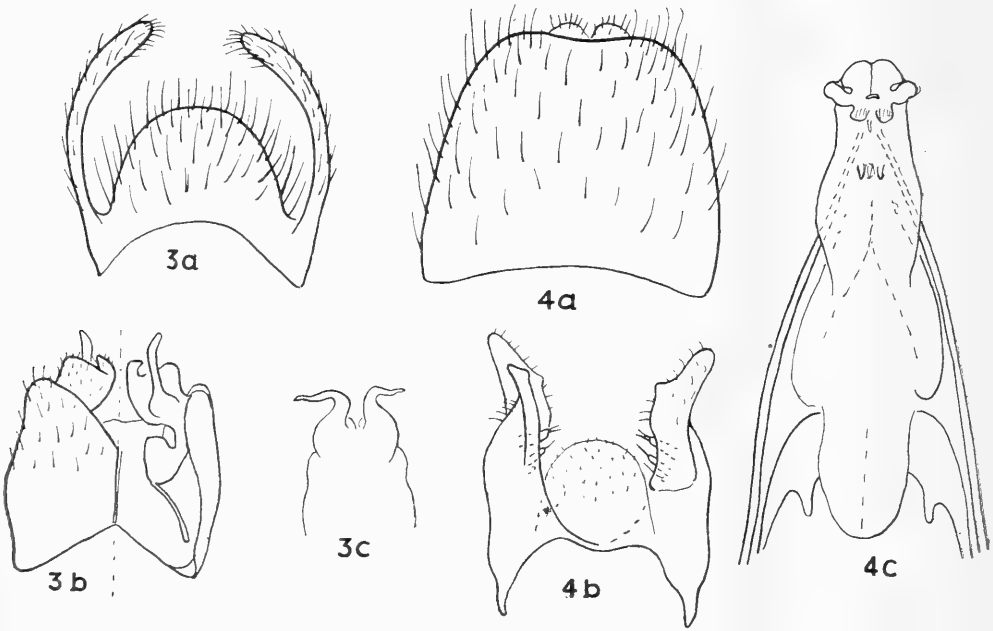
PLATYURA (XENOPLATYURA) DODDI, n. sp. Text-fig. 4.

♂. Head dark brownish, almost black round ocelli; front lighter brown and dusted with grey. Mouth-parts yellowish. Antennae with scape ochreous, flagellum black, scarcely as long as thorax, segments scarcely as long as broad. Thorax brownish-ochreous above, without obvious stripes, sides of mesonotum somewhat lighter and more grey-dusted; pleurae somewhat darker; pronotal lobes and propleurae yellowish. Abdomen black, first two sternites paler, segments 1-6 inconspicuously bordered with yellow posteriorly. Ninth tergite somewhat square, not greatly produced, other parts as in Text-figure 4. Legs yellowish, tarsi dark. On anterior legs about apical half, on hind legs apical third of tibiae with regular rows of setulae. Outer spurs of posterior tibiae more than half as long as inner. Wings clear, untinted. Sc reaching scarcely beyond base of R_5; R_4 straight,

ending well before level of tip of M_2; costa moderately produced, ending well before wing-tip; *r-m* fusion as long as stem of median fork. Halteres yellow. Wing-length 4 mm.

Loc.—Queensland: Townsville (F. P. Dodd); type ♂ in British Museum.

This is evidently allied to *P. conformis* Skuse and *P. schineri* Skuse, differing from both in the uniformly ochreous thorax. Malloch's figures of the hypopygium of *P. conformis* indicate an allied but distinct species.



Text-fig. 3.—*Platyura* (*Neoplatyura*) *richmondensis* Skuse. *a*, ninth tergite; *b*, ninth sternite and appendages, left from below, right from above; *c*, tip of aedeagus.

Text-fig. 4.—*Platyura* (*Xenoplatyura*) *doddi*, n. sp. *a*, ninth tergite; *b*, ninth sternite and appendages, left from below, right from above; *c*, aedeagus (proximal portion of apodemes cut off).

All figures to same scale.

Subgenus Truplaya, nov.

Genotype, *Platyura venusta* Walk. (India).

Additional species: *P. fumipes* Brun. (Ceylon); *Zelmira flavioralis* Speiser (Formosa); *Z. calogastra* Speiser (W. Africa).

Truplaya forms a connecting link between *Isoneuromyia* and *Xenoplatyura*, resembling the former in general appearance, but with the same chaetotaxy and hypopygial structure as in the latter. All the species known to me have a distinctive type of ornamentation; they are black, with conspicuous white apical bands on the second and fourth abdominal tergites, and rather glassy wings. An undescribed species from Sierra Leone has lateral fringes of bristles on the prosternum, but in other respects resembles the other species, which have the prosternum bare (as have all other species of *Platyura* which I have examined, with the exception of *P. fulva* Skuse).

Subgenus TAULYRPA, nov.

Genotype, *Cerotelion vespiformis* Enderlein (Brazil).

Enderlein described a male only. There is in the British Museum a specimen from Para (Bates) which may be a female of *P. vespiformis* or may represent another allied species. The characters of the tibial setulae and spiracular hairs have been noted from this specimen; they were not mentioned by Enderlein.

Subgenus LAURYPTA, nov.

Genotype, *Platyura leptura* Edw. (Malay Peninsula).

Additional species: *P. tripunctata* Senior-White (Ceylon); *P. laevis* End. (Seychelles). All the species are small and delicately built.

Subgenus MONOCENTROTA Edw.

In addition to the genotype (*P. lundstroemi* Edw. of Europe) the Indian *P. indistincta* Brun. may belong here.

According to information supplied by Mr. A. L. Tonnoir, Skuse's genus *Pseudoplatyura* possesses most of the characters of *Monocentrota*, differing mainly, if not solely, in having one segment fewer in the antennae. *Platyroptilon* Westw. (or at least the Ceylonese *P. talaroceroides* White, which is the only species I have examined) is also similar to *Monocentrota* in all respects except for its remarkable pectinate antennae.

Subgenus RALYTUPA, nov.

Genotype, *Platyura pendleburyi* Edw. (Malay Peninsula).

Three or four additional species from Africa are represented in the British Museum collections, but are at present undescribed. In all these the mesonotum is uniformly setulose as usual in this group of subgenera, although in *P. pendleburyi* it has distinct bare lines.

The only other subgenera in which the costa in not distinctly produced beyond R_5 are *Isoneuromyia* and *Taulyrpa*, both very distinct in other respects.

Subgenus RUTYLAPA, nov.

Genotype, *Platyura ruficornis* Zett. (*pectinifera* Edw.) (Europe).

Additional species: *P. juxta* White (*ruficornis* Brun.) (India); *P. penrissenensis* Edw. (Borneo); also an undescribed species in British Museum from Nigeria.

Rutylapa differs from all the other subgenera known to me except *Neoplatyura*, *Taulyrpa* and *Ralytupa*, in the possession of spiracular hairs; from the first it differs obviously in the bare media and cubitus; from the second in the presence of the outer spur on the posterior tibiae; and from the third in the produced costa. The presence of a few postnotal bristles may not be constant.

Subgenus PROCEROPLATUS Edw.
(*Calliplatyura* Mall.)

The two genotypes (*P. pictipennis* Will. and *P. elegans* Coq.) are very closely related and possibly to be regarded as geographical forms of the same species. In addition to these, I am acquainted with three or four Oriental and one African species, most of which have conspicuous wing-markings arranged on a similar plan. The figure given by Skuse of the wing of his *Platyura graphica* shows very similar markings, and I have no doubt that species also belongs here.

Malloch in his diagnosis of *Calliplatyura* states that Sc_2 is absent and each tibia has one long "bristle" (i.e. spur) at apex. He has, however, overlooked the minute outer spur of the posterior tibiae, which is always present; and the subcostal cross-vein, which is also present but only very slightly beyond the level of the humeral.

Subgenus Lutarpya, nov.

Genotype, *Platyura fulva* Skuse.

In the genotype the hind tibiae of the male are somewhat swollen on the middle half, the swollen part clothed beneath and at the sides with very dense irregularly arranged setulae, although the dorsal surface of the tibia bears a few continuous and regular rows of setulae. This may be only a sexual character. The presence of pubescence on the prosternum is very exceptional. The British Museum possesses a male from South Queensland (Bancroft).

Subgenus Lapyruta, nov.

Genotype, *Platyura fasciventris* Will. (West Indies).

In the type the antennae are noticeably flattened, but this may be only a specific character. There are curious sexual differences: in the ♂ the abdomen is compressed, broadest in the middle, with segments 2 and 3 longer than the others and projecting ventrally; the inner spurs of the hind tibia are peculiar: stout and yellowish on the basal portion, more swollen and black just before the acuminate tip. In the ♀ both abdomen and spurs are normal. The species was wrongly described as having only one spur on each tibia; actually the outer spurs are well developed.

Subgenus Platyura Meig., s. str.

Genotype, *Platyura fasciata* Mg. (Europe).

Additional species: *P. apicipennis* Brun., *P. affinis* Brun., and *P. flaviventris* Brun. (India); *P. nemoralis* Mg., *P. pallida* Staeg., *P. nigricornis* Fab. and *P. discoloria* Mg. (Europe); *P. fascipennis* Say and probably *P. moerens* Joh., *P. diluta* Lw., *P. subterminalis* Say and *P. moesta* Joh. (North America).

Subgenus Tylparua, nov.

Genotype, *Platyura hawaiiensis* Grimshaw (Hawaii).

Additional species: *P. insularis* Grimshaw and probably *P. fuscocostata* Grimshaw (Hawaii).

Another species possibly belonging here is *P. funerea* Brun. (India), which also lacks the median ocellus, but its other characters have not been fully described. *Tylparua* is evidently most closely allied to *Platyura*, s. str., differing chiefly in the absence of the median ocellus. In the genotype the antennae of the male are unusually long and the wings of the female peculiar in shape; the mediotergite is quite bare. In *P. insularis* the mediotergite bears a few very small bristles apically, so that this character does not form a clear distinction from *Platyura*.

Asindulum Latr.

The genotype (*A. nigrum* Latr.) has the postnotal pleuro-tergites and mediotergite bare; a patch of short hair on the anepisternite; no spiracular hairs; mesonotum with bare lines; tibial setulae irregularly arranged; *An* nearly reaching

margin; no setulae on branches of media and cubitus. No group of *Platyura* known to me possesses this combination of characters, but the hypopygium suggests an affinity with *Urytalpa*.

A. flavum Winn. (genotype of *Macrorrhyncha* Winn. and *Adelinia* Costa) differs from *A. nigrum* in having a few short bristles on mediotergite; several spiracular hairs; no hairs on the anepisternite; *An* more abbreviated; and close-set rows of small setulae on branches of media and cubitus. *A. rostratum* Zett. is similar to *A. flavum*, except in lacking the postnotal bristles. These two species may be placed in a separate subgenus *Macrorrhyncha*; except for the elongate mouth-parts they have all the characters of *Neoplatyura*.

Antlemon Hal.
(*Helladipichoria* Beck.)

The two species of this genus, as I have previously pointed out, differ essentially from *Asindulum* in the structure of the labium, which has the theca elongate but the labella very small. It may now be noted that they have the branches of the media and cubitus bare, but agree with *Asindulum* (subgenus *Macrorrhyncha*) in having a few spiracular hairs and a bare anepisternite; the postnotum is quite bare, and tibial setulae irregular.

Ceroplatus Bosc.

The essential distinction between *Ceroplatus* and *Platyura* is in the structure of the mouth-parts: in the former the labium is more or less atrophied, and the maxillary palpi are porrect and consist of one swollen segment; whereas in the latter the labium is well preserved and the maxillary palpi are incurved, with three slender segments. Johannsen in 1909 recognized *Cerotelion* as a genus distinct from *Ceroplatus* on the basis of the venation (R_4 ending in costa), a restriction which I accepted in 1925 and which Malloch followed in his recent paper. I now consider, however, that the venational difference is of less moment than some other distinctions which occur among species which have been referred to *Cerotelion*, and therefore propose to include this latter (as well as *Heteropterna*) as a subgenus of *Ceroplatus*.

Malloch has called attention to the existence of short hairs on the anepisternite in some species of *Ceroplatus*. I find that these hairs are too variable and inconstant to be made the basis of subgeneric division, and the same is true of the bristly hairs on the prosternum. Contrary to what we find in *Platyura*, most species of *Ceroplatus* have a hairy prosternum, but the hairs are variable in number and length and in one or two species are absent.

It may be noted that all species of *Ceroplatus* have the lower front bare; mesonotum uniformly setulose; spiracular hairs absent; hypopleurite and mediotergite bare; outer spur of hind tibiae well developed; and branches of media and cubitus bare. It would thus seem that all have been developed from a group of *Platyura* having most of the characters of the subgenus *Proceroplatus*.

I propose to recognize six subgenera of *Ceroplatus*, distinguished as follows:—

1. Tibial setulae irregularly arranged, unless at extreme tip of tibia; R_4 ending in costa 2
   Tibial setulae in regular rows throughout 4
2. Pleurotergites hairy; middle and hind tibiae with small dorsal and external bristles ..... *Mallochinus*, n. subg.
   Pleurotergites bare 3

3. Tibiae with small dorsal and external as well as internal bristles; hind tibia slightly and evenly enlarged from base to apex; first hind tarsal segment not at all thickened, its bristles rather irregular; tibial spurs black as usual; face broad ..... *Cerotelion* Rond.
   Tibiae without bristles except a few on inner (posterior) side of middle and hind tibiae; hind tibia rather suddenly enlarged on apical third or fourth; first hind tarsal segment more or less thickened and with two very regular ventral rows of short bristles; tibial spurs yellow; face narrow ..... *Heteropterna* Skuse.
4. Pleurotergites bare; posterior tibiae with small dorsal and external bristles; R_4 ending in costa ..... *Euceroplatus*, n. subg.
   Pleurotergites hairy; posterior tibiae with small internal bristles only 5
5. R_4 ending in R_1; three ocelli as usual; face not very narrow; front tarsi not remarkably long ..... *Ceroplatus*, s. str.
   R_4 ending in costa; two ocelli; face very narrow; front tarsi very long, first segment twice as long as tibia ..... *Placoceratias* End.

Subgenus MALLOCHINUS, nov.

Genotype, *Ceroplatus mastersi* Skuse.

This agrees with *Cerotelion* in having the face moderately broad; eyes deeply emarginate above roots of antennae; and lateral ocelli almost touching eye-margins. An apparently undescribed species is represented in the British Museum from Tasmania.

CEROPLATUS (MALLOCHINUS) MANGALORENSIS, n. sp.

Differs from *C. mastersi* Skuse, as follows:—Antennae entirely black. Pleurotergites entirely yellowish. Hind femora with a broad dark brown ring close to base. Apical dark cloud of wing extending into tip of cell R_1.

Loc.—Tasmania: Mangalore, 17.ii.1913 (A. White); type in British Museum (abdomen missing).

Subgenus CEROTELION Rond.

In addition to the genotype (*C. lineatus* F., of Europe) several species of this subgenus occur in New Zealand; of those described by Tonnoir and myself in our recent revision *C. hudsoni* Hutt., *C. leucoceras* Marsh., *C. bimaculatus* Tonn., and *C. tapleyi* Edw. certainly belong here, and it seems probable that this is the only subgenus occurring in New Zealand. I have also taken an example of another species, apparently undescribed, at Washington, D.C.

Subgenus HETEROPTERNA Skuse.

I have not seen either of the two Australian species described by Skuse, but *C. quadripunctatus* Brun. of India agrees in almost every detail with Skuse's description of *Heteropterna*, and I have used material of this species in drawing up my definition of the subgenus. It is of interest to note that both the Australian and Indian species were taken in spiders' webs.

Cerotelion major Curran (Jamaica) is remarkably like *C. quadripunctatus*, and though the type in the British Museum is legless and otherwise damaged, I have no hesitation in referring it to this subgenus.

Subgenus EUCEROPLATUS, nov.

Genotype, *Ceroplatus notaticoxa* Senior-White (Ceylon).

This subgenus does not differ greatly from *Cerotelion*, except in the regular alignment of the tibial setulae. In the genotype the prosternum is bare, but in *C. bellulus* Will. (Mexico), which seems also to belong here, it is hairy as usual. In both the face is narrower than in *Cerotelion*, the eye less emarginate above insertion of antennae, and the lateral ocelli remote from the eye-margins.

Subgenus CEROPLATUS Bosc., s. str.

I have examined two European and one North American species, all of which conform to the diagnosis in the above key.

Subgenus PLACOCERATIAS End.

This subgenus, founded by Enderlein for two Brazilian species, also includes the West Indian *C. longimanus* Will., which is in all essentials similar to the other two.

A GARNET-BEARING DYKE NEAR MORUYA, NEW SOUTH WALES.

By Ida A. Brown, B.Sc., Linnean Macleay Fellow of the Society in Geology.

(Plates ix-x.)

[Read 26th June, 1929.]

Field Occurrence.

On the headland known as Kelly's Point, 10 miles south-east of Moruya, on the South Coast of New South Wales, is an exposure of a basaltic dyke, which contains inclusions of an unusual character. Brief reference has been made to this occurrence in a previous paper on the general geology of the Moruya District, published in These Proceedings (1928), where the position of the dyke is indicated on the map of Kelly's Point given in Text-figure 3, page 157.

The dyke is exposed on the north-easterly portion of the headland which projects out into the sea for some distance from the general trend of the coast-line; it is vertical, and runs in a direction approximately W. 25° S. and E. 25° N. The dyke is between three and four feet in width in the eastern portion of its course, but divides into two veins in a westerly direction. It intrudes the tonalite or quartz-diorite, which is intrusive into the diorite-gabbro also outcropping on the Point, and it cuts through a wide aplite dyke, which is magmatically related to the Moruya tonalite and granodiorite.

Traces of the dyke are found in the soil a couple of hundred yards to the west, but further outcrop is obscured by soil formation.

On the shore of Lake Coila, in portion 249, parish of Congo, one and three-quarter miles from Kelly's Point in a direction W. 20° S., is an exposure of another dyke which somewhat resembles that at Kelly's Point. Its strike is approximately E. 10° N.; unfortunately there are no outcrops of these dykes between the localities mentioned, the whole intervening area being under grass and cultivation, but the directions and bearings of the two outcrops are such that they may be parts of one and the same curved dyke-intrusion.

Petrographic Description.

The general character of the dyke at Kelly's Point is basaltic, and its chief interest lies in the inclusion of numerous fragments of foreign basic and ultra-basic plutonic rocks. In some places the inclusions comprise more than one-third of the total volume of the dyke-rock (Plate ix, figs. 1, 2).

The basalt is aphanitic, and dark bluish-grey to black. In thin section it is seen to be holocrystalline and even-grained, the average grainsize being about 0·2 to 0·3 mm., with pilotaxitic, fluidal fabric. It consists of a plexus of small plagioclase (andesine) laths, with interstitial ferromagnesian minerals, including some colourless augite and brown hornblende with their alteration products, and also some iron ore. No nepheline or analcite has been detected under the microscope.

Inclusions in the Dyke.

In the field, portions of the dyke appear to be literally crowded with foreign inclusions, but as the best exposure of the dyke occurs between tide marks on a rocky headland, marine erosion has so smoothed the rock surfaces that some difficulty is experienced in obtaining specimens for laboratory examination. Thus, although a variety of inclusions has been obtained from this dyke, there is little doubt that other types may exist therein.

Generally the xenoliths are approximately spheroidal, and are from a few millimetres to about five centimetres in diameter; most of the smaller ones consist of a rather fine-grained rock similar to the groundmass of the dyke on the shore of Lake Coila, while the others consist of more coarsely crystalline gabbroic rocks, which bear striking resemblances to inclusions in the volcanic necks and some of the dykes of the Sydney District. Nearly all of the inclusions appear to have suffered a certain amount of magmatic alteration, and one finds in thin sections small patches of confused aggregates of secondary minerals, evidently representing various stages in the assimilation of the foreign rock-material by the basaltic magma.

Micro-sections of these rocks reveal the presence of several types of inclusions; small fragments of a finely-grained keratophyric rock are abundant, while basic and ultrabasic types are represented by anorthosite, gabbro, (?) lherzolite (pleonaste-bearing), a pleonaste-pyroxenite (variety websterite), and fragments of a garnetiferous ultrabasic plutonic rock. So far no peridotites or serpentines have been discovered in this dyke.

The keratophyric rock occurs as abundant inclusions as small as 1 mm. in diameter. It is somewhat similar to but not quite identical with the groundmass of the dyke outcropping on the shore of Lake Coila, and is of a lighter colour and slightly more coarsely grained than its host. Its orthophyric fabric is due to the arrangement of stumpy crystals of felspars, probably both albite and orthoclase, with numerous small idiomorphic crystals of brown hornblende; apatite is very abundant in tiny acicular crystals, chiefly as inclusions in the felspars.

Anorthosite.—A small fragment of rock consisting of several allotriomorphic grains of basic plagioclase occurs in one rock-section. The felspar has well developed albite and pericline twinning and shows a schiller structure due to the formation of tiny grains of brown hornblende along the planes of albite twinning. Portion of the felspar is altered to finely-divided decomposition products, including some calcite.

Gabbro.—This is a coarsely-crystalline rock containing large idiomorphic plagioclase (andesine) crystals up to 1 cm. in length, which show twinning after albite, pericline and Carlsbad laws. The felspar is remarkably fresh, and has evidently crystallized before the original ferromagnesian mineral, thus producing an ophitic fabric in the rock. This interstitial mineral has been altered almost beyond recognition, and there appear now only a few patches of unaltered colourless augite, and some grains of slightly pleochroic hypersthene, surrounded by brown hornblende, which is changing into bluish-green secondary amphibole, possibly smaragdite. A great deal of finely divided iron ore, epidote, chlorite and carbonate material has also been produced as a result of the alteration of original pyroxene.

The presence of hypersthene indicates an affinity with the norites.

(?) *Lherzolites.*—Rocks at least allied to the lherzolites occur in some sections. These consist essentially of pyroxenes, the monoclinic dominating

over the rhombic variety, whilst olivine is represented only by its pseudomorphs. In one section there is a trace of basic plagioclase. An interesting feature in these rocks is the presence of accessory spinel. The pyroxenes, both monoclinic and rhombic, occur as allotriomorphic grains from 1 mm. to 1 cm. in diameter, and present no features of special interest. In the rhombic variety the pleochroism is but slightly perceptible, and the colourless augite shows partial alteration to a variety of brown hornblende, which is probably magmatic, and which changes into greenish secondary amphibole.

The olivine-pseudomorphs consist of felted aggregates of carbonates and finely-divided silicates, probably including talc, epidote and actinolite with some "released" iron oxides.

Some bleached biotite is associated with the olivine-pseudomorphs.

There appear to be two varieties of spinel present as accessory minerals: The one is transparent, and of a green colour, shows no cleavage but may be irregularly cracked, and is quite isotropic. It is evidently pleonaste, and forms small individual grains and also occurs as the cores of grains of more opaque spinel, which show a brownish tint on thin edges. The latter is probably picotite. The spinels occur only as small irregular grains, and no graphic intergrowths with other minerals, such as those described by W. N. Benson and G. D. Osborne, have been noticed.

Pleonaste-bearing Pyroxenite.—This rock is undoubtedly genetically related to the lherzolite described above, and contains pyroxenes, both monoclinic and rhombic, but is devoid of olivine or plagioclase. Thus it is a pyroxenite, variety websterite. Brown hornblende is again present as an alteration product of the pyroxene. A remarkable feature of this rock is the relative abundance of spinel, chiefly pleonaste, which constitutes about 8 per cent. of the rock. It occurs as rounded and irregular grains about 0·5 mm. in diameter and is evenly distributed throughout the rock; no graphic intergrowths were observed, but as in the lherzolites the pleonaste is sometimes surrounded by more opaque brownish picotite (Plate x, fig. 4).

In addition to the obvious xenoliths there are some relatively large crystals of red garnet, brown hornblende, augite, basic plagioclase, and some ilmenite, which usually exist as individual inclusions, but which also occur in association with each other in the manner described below.

The garnet occurs as well-formed crystals from 1 cm. to 2 cm. in diameter, red in colour, with a narrow black border. In thin section the mineral appears pink; it is much cracked and is quite isotropic. The kelyphitic ring consists partly of pale green fibrous radiating minerals and partly of iron ore (Plate x, figs. 1, 2); it appears to be the result of corrosion of the xenocryst by the groundmass, and therefore, in this case, does not "represent a stage in the development of garnet from the products of the molecular disintegration of original ferromagnesian silicates" as described by Sederholm (1916). No complete chemical analysis of the garnet has been made, but the mineral gave reactions for a silicate, and determinations of the content of ferrous oxide and manganous oxide gave results of 23·62 per cent. and 1·23 per cent. respectively. The specific gravity is 4·2 at a temperature of 20·1° C. These results indicate that the mineral belongs to the pyrope-almandine series, and probably contains about equal proportions of pyrope and almandine molecules.

Brown hornblende occurs as crystals as large as 5 cm. by 2½ cm. by 2 cm. and appears black in the handspecimen, with well-developed cleavage. In thin section

it is pale yellowish-brown, with very strong pleochroism from pale yellowish-brown to dark reddish-brown. No chemical analysis of this hornblende has been made, but the mineral appears to be similar to that occurring as xenocrysts in an "analcite basalt" forming a sill in the Bulli Colliery. Mr. G. W. Card (1915, p. 350) quotes a partial analysis of these hornblende xenocrysts, which is remarkably close to that of the typical basaltic hornblende from Bilin, Bohemia, described and analysed by Penfield and Stanley (1907). These two analyses are compared below. The chief distinction between the two analyses lies in the condition of the iron oxides; the total percentages of iron oxides are practically the same, but whereas the iron in the Bohemian hornblende is chiefly in the ferric state, the Bulli variety contains only ferrous oxide.

	I.	II.
SiO_2	39·95	39·90
Al_2O_3	17·58	17·78
Fe_2O_3	7·25	abs.
FeO	2·18	9·45
MgO	14·15	12·86
CaO	11·96	10·34
Na_2O	3·16	2·66
K_2O	1·98	1·34
H_2O+	0·41	0·62
H_2O-	0·13	
TiO_2	1·68	2·50
MnO	tr.	0·06
F_2	0·03	—
	100·46	
$O = F_2$	0·01	
	100·45	

I. Basaltic Hornblende from Bilin, Bohemia. S. L. Penfield and F. C. Stanley, *Amer. Journ. Sci.*, xxiii, 1907, p. 47.

II. Hornblende Xenocrysts from Bulli Colliery Sill, incomplete analysis quoted by G. W. Card, *Mem. Geol. Surv. N.S.W.*, Geol. No. 7, 1915, p. 350.

Some micro-sections of the hornblende show a uniform character throughout the entire crystal section, but others show very definitely that the brown hornblende owes its origin to an alteration of augite which is almost certainly magmatic. In some instances the magmatic change has affected a large individual plate of augite (Plate x, fig. 3), in others several smaller grains are involved. In either case the hornblende has formed originally at the expense of the augite, and later continued developing to form large idiomorphic crystals.

The augite crystals are slightly smaller and not so abundant as hornblende. The mineral has a faint pink colour in thin section and has slight pleochroism.

Plagioclase is common in tabular crystals as large as one or two centimetres in diameter. It is white in the handspecimen, and in thin section is seen to be basic andesine; it shows partial resorption on the edges, but is otherwise quite fresh.

Apatite occurs as relatively large crystals as inclusions in both plagioclase and garnet, and some ilmenite is also present in association with these xenocrysts.

Several sections show that these "xenocrysts" are probably fragments of a very coarsely crystalline plutonic rock, which to a great extent was shattered to its constituent minerals during its passage upwards in the dyke. The rock seems to have been originally of the nature of a garnet-bearing eucrite, in which the pyroxene was partially replaced by amphibole.

Although no single section yet cut from this rock contains all the minerals together, an examination of several sections shows a fairly definite order of consolidation in the original rock. Apatite and iron ore crystallized first and were included in the later-formed minerals, the pyroxene then commenced to separate out and was partly replaced by hornblende, which continued crystallizing for a considerable period. It is idiomorphic towards the felspar, which formed later, while the garnet may partly or entirely enclose small idiomorphic crystals of felspar, thus appearing to have been the last mineral to have crystallized out.

This extraordinary rock seems to be typically igneous, and is probably a deep-seated type whose existence is revealed at the surface of the earth only under exceptional circumstances.

The dyke on the shore of Lake Coila resembles that at Kelly's Point, in that it contains large xenocrysts of brown hornblende and plagioclase; no garnets have been noticed in this dyke, but it contains idiomorphic plates of biotite about 1 cm. in diameter. The rock is of a lighter colour than the garnet-bearing dyke, and is somewhat similar to the small included fragments of keratophyric rock in the latter dyke, which have been described above (Plate ix, fig. 3).

The Origin of the Inclusions.

The problem of the origin of the inclusions is one which affects not only the dyke under consideration, but also many somewhat similar occurrences in the eastern part of New South Wales.

Some previous writers on this subject are of the opinion that the xenoliths are comagmatic with the material of the host, but the writer suggests that the available evidence does not indicate that any petrogenetical relationship necessarily exists between the host and the inclusions. The extraordinary character and variety of the inclusions, particularly the garnet, brown hornblende, and ultrabasic xenoliths, and the amount of corrosion and assimilation they have suffered, proves at least that they did not crystallize in the position in which they are now found.

With the exception of garnet the xenocrysts consist of minerals which occur commonly in igneous rocks. Garnet is of more rare occurrence as a mineral of primary crystallization, but is a constituent mineral of the rock eclogite: although some eclogites are the products of plutonic metamorphism, others may be of primary igneous origin, having crystallized under great hydrostatic pressure. Eclogites of the latter type have been described from Norway by P. Eskola (1921), and are probably derived from an ultrabasic magma, originating deep in the earth's crust.

No intrusive masses of eclogite are known to outcrop in New South Wales, but fragments of eclogites occur as "boulders" in dykes and necks of volcanic breccia. E. F. Pittman (1909) described the occurrence of eclogite in six localities in New South Wales, and G. W. Card (1905) recorded another occurrence at Mullimbibby, Snowy River. The garnet in the eclogite of the volcanic neck at Ruby Hill, 12 miles south of Bingera has been described fully by G. W. Card (1902), who quotes an analysis of this garnet made by J. M. Curran (1896); the mineral has a pink colour and is considered to belong to the pyrope group.

Micro-sections of these rocks have been made available for examination by the courtesy of Mr. M. Morrison, Acting Curator of the Mining Museum, Sydney. The garnets of the eclogites of Wollondibby (Snowy River) and Bundundah (Yalwal District) most closely resemble those at Kelly's Point so far as colour is concerned, but the garnets of the eclogites are always much smaller.

Professor L. A. Cotton has called the writer's attention to the fact that primary garnet of a similar character to that at Moruya occurs in an andesitic dyke intruding the volcanic series at Mt. Fuji, Japan.

A re-examination of the rocks of the Mount Dromedary District, in which W. Anderson (1892) reported the presence of garnet, shows that except in one case, the mineral is actually sphene.

An occurrence somewhat similar to that on the South Coast has been described by B. Dunstan (1901), of a garnet-bearing basaltic dyke near Lowood, 21 miles north-west of Ipswich, Queensland. In the basalt the garnets "are corroded and rounded on the outside of the crystal, and very much fractured internally. The colours are shades of pale reddish-brown to a deep blood red, with an absence of violet tints" . . . . "As inclusions in the basalt the garnets are associated with hornblende and titanic iron (both of which show the effects of corrosion by the basalt)."

The brown hornblende is also of special interest, as it has been found as xenocrysts in a number of monchiquite and camptonite dykes of the Illawarra district and elsewhere, the occurrence of which has been discussed by G. W. Card (1915), who states "There is reason to believe that hornblende xenoliths of the same character occur under similar conditions as far north as Glen Innes and as far south as Bombala—five hundred miles—while they have also been noticed at Mudgee, to the west."

The presence of ultrabasic xenoliths associates the dyke at Kelly's Point with others of the Illawarra District, and with the volcanic necks at Dundas and the Basin, Nepean River, all of Post-Triassic age.

The monchiquite dyke a mile south of Gerringong has attracted considerable attention on account of the variety of its inclusions. It was noted by L. F. Harper and G. W. Card (1915) and described in more detail by W. N. Benson (1914), who found inclusions of "alkali-felspar-gneisses and quartz-schists, with a few gabbroic rocks". New microsections of a specimen collected from this dyke in 1927 reveal the presence of the spinel, picotite, as small xenocrysts and as a constituent mineral in fragments of lherzolite, which contains also enstatite, olivine and augite (Plate x, fig. 5). This rock is apparently similar to the enstatite peridotite described by C. A. Sussmilch (1905) from a dyke at Bumbo, two miles north of Kiama and closely resembles the lherzolite in a dyke at The Basin, Nepean River, described by G. D. Osborne (1920), who has kindly allowed the writer to examine his rock sections.

W. N. Benson (1910) has described in detail a series of plutonic inclusions in the volcanic neck at Dundas, which bears such a striking resemblance to some of the inclusions in the dyke near Moruya, that many of his observations are equally applicable to both series. The varieties and characters of the individual minerals present in these xenoliths are similar, even to the occurrence of the somewhat rare spinels, pleonaste and picotite; furthermore the minerals are similarly associated to form ultrabasic rocks in which the pyroxenes usually dominate over either olivine or plagioclase. As yet no peridotites have been observed in the Moruya dyke, while garnet-bearing rocks are not known to occur at Dundas.

When discussing the origin of the inclusions at Dundas, Professor Benson (1910, p. 551) considered that the plutonic rocks occurring as inclusions were probably consolidated portions of the basaltic magma, and Mr. Card (1903)

expressed a similar view of the consanguinity of the "exogenic igneous fragments" and the Tertiary basalts. Both writers recognized the difficulty of assuming "the existence of a batholith of basic and ultrabasic rocks underlying nearly the whole of the eastern portion of New South Wales", and therefore Professor Benson favoured the idea of the existence of a number of "small highly-differentiated bodies".

This theory assumes that magmatic differentiation proceeded along identical courses for a considerable period of time in numerous small independent reservoirs, which contained magma of similar chemical composition, and that injection of liquid magma took place at similar stages in the cooling history of each reservoir.

No reliable chemical evidence of the consanguinity of the basalts and the inclusions has yet been produced; a consideration of the published analyses of the basalts and inclusions from Dundas, Hornsby and The Basin, and an attempt to obtain a variation-diagram of the series, fail to give any indication of their comagmatic origin. Although the rocks are quite basic, the total iron content is always below that of average basalt; the plutonic inclusions are essentially calcic, although the basalts are alkaline, and have a composition very close to that of average nepheline-basalt. The other oxides show irregularities incompatible with the idea of serial magmatic differentiation of an alkaline basaltic magma.

Even if the composition of the original basaltic magma were such as could produce types similar to those of the xenoliths, there is evidence to show that they may equally well have been derived from an entirely different magma. On the South Coast near Mt. Dromedary pyroxenites which are quite comparable with the pyroxenites of the inclusions, both mineralogically and chemically, have been produced by the differentiation of a monzonitic magma, and even more basic types might be expected at a depth.

Although outcrops of ultrabasic rocks in this State are comparatively rare, it seems highly probable that such rocks do exist below the surface, possibly in a complementary relationship to the enormous Devonian and Permo-Carboniferous batholiths of granite and granodiorite which outcrop over such a great area in eastern New South Wales. This suggests an explanation for the widely-scattered occurrences of ultrabasic rocks, while their inclusion in rocks of Tertiary age may be due to special tectonic conditions prevailing about the time of the intrusion of the basalt.

During the close of the Tertiary period great epeirogenic movements took place in Eastern Australia, and these were associated with the uprise of much basaltic magma which, in its passage towards the earth's surface, might have passed through and included fragments of already consolidated ultrabasic rocks, not necessarily comagmatic with it.

This suggestion of the ultimate origin of the inclusions seems no less possible, and to the writer far more probable, than previous theories, while an explanation is offered for their peculiar occurrence only in certain hypabyssal rocks of Cainozoic age.

Summary and Conclusions.

A record is given of a basaltic dyke outcropping on the coast of New South Wales, ten miles south-east of Moruya, which contains fragments of basic and ultrabasic plutonic rocks, including particularly pleonaste-bearing pyroxenites and

large xenocrysts of red garnet, brown hornblende, augite and basic plagioclase, which probably constituted a coarsely crystalline garnet-bearing eucrite.

A consideration of similar occurrences elsewhere has led the writer to believe that the inclusions are most probably truly xenolithic in origin, and not comagmatic with the basalt, while their inclusion in Cainozoic hypabyssal rocks may be due to special tectonic conditions which prevailed over the tablelands and coastal area of Eastern Australia during late Tertiary time.

In conclusion the writer is indebted to Mr. G. W. Card, Mr. M. Morrison and Mr. G. D. Osborne for permission to examine sections of various rocks from New South Wales; to Mr. H. G. Gooch of the Geological Department, Sydney University, for the rather difficult preparation of a series of rock-sections and also for assistance in micro-photography; and to Dr. W. R. Browne for his interest in and friendly criticism of the work; to all of whom the writer expresses her sincere thanks.

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EXPLANATIONS OF PLATES IX-X.

Plate ix.

1.—Basalt containing inclusions of red garnet and pyroxenite. Dyke, Kelly's Point, Moruya District. Natural size.

2.—Basalt containing xenocrysts of hornblende, garnet and plagioclase. Sliced specimen. Dyke, Kelly's Point, Moruya District. Natural size.

3.—Keratophyric dyke-rock containing xenocrysts of hornblende and plagioclase. Sliced specimen. Lake Coila, Moruya District. $\frac{7}{10}$ natural size.

Plate x.

1.—Micro-section, showing portion of garnet xenocryst with kelyphitic ring containing a large proportion of iron oxide. Dyke, Kelly's Point, Moruya District. Plane polarized light. × 11⅝.

2.—Micro-section of another portion of kelyphitic ring surrounding garnet xenocryst, high power. Dyke, Kelly's Point. Plane polarized light. × 30¾.

3.—Micro-section, portion of large idiomorphic crystal of brown hornblende, showing core of colourless augite in lower right-hand corner, and preservation in hornblende of original diallagic striation. Dyke, Kelly's Point. Plane polarized light. × 15.

4.—Micro-section of xenolith of pleonaste-bearing pyroxenite. The green spinel appears as irregular black grains in the photograph. Dyke, Kelly's Point. Plane polarized light. × 19⅛.

5.—Micro-section of xenolith of picotite-bearing lherzolite, showing large irregular grain of picotite associated with pyroxenes and olivine. Monchiquite Dyke, 1 mile south of Gerringong. Plane polarized light. × 19⅛.

THE SOCIETY'S HERITAGE FROM THE MACLEAYS. Part ii.

By the late J. J. Fletcher.*

Sir William (John) Macleay, M.L.C., F.L.S.

The record of Sir William Macleay's life-history may be divided into four chapters: (1) 1820-1839—the prelude to his Australian career, including an eventful voyage from London to Sydney; (2) 1839-1855—the transition from "new chum" to practical pioneer squatter, managing the station in which he was interested; (3) 1856-1873—election to Parliament, permanent residence in Sydney, marriage, resumption of intercourse with his cousin, William Sharp Macleay, reawakening of his interest in Natural History, becomes an entomologist with his own collection and scientific library, succeeds to the joint collections of Alexander and William Sharp Macleay; (4) 1874-1891—retires from Parliament in order to devote himself to the study of Natural History and the improvement of his museum, henceforth a working zoologist, promoter and benefactor of Science in New South Wales.

He was temperamentally disinclined to talk about himself or his doings and I think that his habitual reticence in this respect was emphasized by his lonely life as a squatter on the Lower Murrumbidgee, remote, not merely from Sydney, but from the nearest country town.

The original published sources of information of a biographical character concerning William Macleay are:—

(1). The short notice, less than half a page, merely a brief statement of elemental facts with but few details, given in J. Henniker Heaton's "Australian Dictionary of Dates and Men of the Time" (p. 127), published in 1879.

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* *Note by the Publication Committee.*—The preparation of an account of the Society's Heritage from the Macleays was undertaken by the late J. J. Fletcher in connection with the celebration by the Society, in June, 1920, of the centenary of the birth of William Macleay. On that occasion Mr. Fletcher, as President of the Society, delivered an address, the first portion of which dealt with the part played by Alexander Macleay and his two sons, William Sharp and George, in the Macleayan succession and in the accumulation and development of the Macleay Collections. This portion was published in the Proceedings for 1920, pages 567-635. The second part of the address dealt with the life-history of William Macleay, but the preparation of this for publication was never completed by Mr. Fletcher. He had, however, accumulated a mass of interesting information, much of which had not been published, since he had had access to William Macleay's private journals and had conducted numerous inquiries concerning William Macleay subsequent to the publication of biographical notices.

After Mr. Fletcher's death this vast mass of material was very kindly placed at the disposal of the Society by Mrs. Fletcher. The Secretary, Dr. A. B. Walkom, has spontaneously undertaken the onerous task of selecting, ordering and preparing for publication the details of the life and work of William Macleay. Thus the results of Mr. Fletcher's industrious and loving researches have been made available for the Proceedings of the Society, which owes a great debt to Dr. Walkom for his laborious work in the preparation.

(2). A biographical sketch of "The Hon. William Macleay, M.L.C., President Linnaean Society", in the bound volume entitled "The Australian Portrait Gallery and Memoirs of Representative Colonial Men", published by the Southern Cross Publishing Company, 96 Pitt Street, Sydney. These Memoirs were apparently written by a capable journalist (perhaps more than one) whose name is not mentioned, possibly after interviews with the surviving subjects of the Memoirs. The date 1884 appears on the last page, but as the concluding portion of the volume is entitled "The History of the Soudan Expedition: An Historical Record of the Events relating to the Levy, Despatch and Return of the New South Wales Contingent raised for Service in Egypt, March-June, 1885", the date of issue must have been later than 1884.

(3). A brief biographical sketch, with a portrait, which appeared in the *Town and Country Journal* of June 8th, 1889, shortly after the public announcement that the honour of knighthood had been conferred on William Macleay.

(4). The Obituary Notice of the Hon. Sir William Macleay, M.L.C., F.L.S., which appeared in the *Sydney Morning Herald* of December 8th, 1891, the day after his death. This was written by a member of the staff of the *Sydney Morning Herald* after an interview with me. Apart from scientific details, this is the most important general biographical sketch available.

(5). An Obituary Notice of Sir William Macleay, M.L.C. in the *Illustrated Sydney News* of December 19th, 1891.

(6). From a scientific point of view, and for an account of the Macleay Museum after the Macleay Collections had been handed over to the University of Sydney, Professor Haswell's Presidential Address to the Society at the Annual Meeting on January 27th, 1892, is very important (PROCEEDINGS, 1892, pp. 2-10).

(7). The Introduction to the "Macleay Memorial Volume" published by the Society in 1893, written by me, at the request of the Council, is a very imperfect biographical record. But I am now able to supplement this in some important respects, from sources of information which were not then available.

(8). The Presidential Address delivered by Dr. T. Storie Dixson to this Society on 30th March, 1904 (see PROCEEDINGS, 1904, pp. 5-23).

Others, including the brief memorial notices in the *Proceedings of the Linnean Society of London*, in the *National Dictionary of Biography*, and Mennell's *Dictionary of Australian Biography* (1892), were only variants of the old theme. In their entirety these notices are a very incomplete record of William Macleay as a meritorious and enterprising Australian. The first three in the above list were published during his life-time. The brief particulars given in the first one, may, by request, have been communicated by himself. The second and third were written by journalists, without personal knowledge, except that chatty interviews may have been granted to one or perhaps both of them. The sixth and seventh were contributed by contemporaries, of a later generation, with some personal knowledge of the concluding chapter of William Macleay's life-history, but without adequate knowledge of the earlier chapters. What is obviously lacking is anything in the shape of a contribution from William Macleay himself or from a contemporary approximately of his own standing as a colonist. For this omission, unfavourable circumstances are responsible.

Two intimate friends, with literary qualifications and with personal knowledge covering a long period, who had known William Sharp Macleay and were familiar with Macleayan history, and who had been closely associated with William

Macleay (1820-91) and had shared his interests in different ways—The Right Honorable William Bede Dalley (1831-88; born in Sydney) and Professor William John Stephens (1829-90; resident in Sydney from 1856)—could have supplied just the kind of information that is lacking. But the careers of both of them, though both were some years younger, terminated shortly before his own. Tributes from both, uttered and recorded during their limetime, are referred to later.

William Bede Dalley and William Macleay were Members of the First Legislative Assembly, 1856-57, when the latter was still a squatter, and, for some time afterwards, of successive Parliaments. From 1875 they were Members of the Legislative Council. In his hours of recreation, Mr. Dalley was an enthusiastic fisherman, and had an excellent sporting knowledge of the fishes of Port Jackson and the coastal waters. He took great interest in William Macleay's efforts to accumulate an ichthyological collection from 1874 onwards, was always on the look out for desirable rare or new species, and was the donor of many interesting specimens to the Macleayan Collection, as recorded in William Macleay's Journal. He was a member of the Royal Commission appointed on the 8th January, 1880, to inquire into and report upon the actual state and prospects of the Fisheries of New South Wales, of which William Macleay was President. He was an Original Member of the Linnean Society of New South Wales; and one of the speakers on the occasion of the dedication of the Linnean Hall at Elizabeth Bay to the Society on October 31st, 1885. He was also a Trustee of the Australian Museum.

Professor W. J. Stephens was in close touch with William Macleay in his scientific work, almost throughout his scientific life. They had co-operated in carrying on the Entomological Society of New South Wales, and especially, later on, the Linnean Society of New South Wales. He was also interested in William Macleay's efforts to develop the Macleay Collection into a general Collection, and, especially in the early stages of the work, lent a helping hand in sorting, bottling, and naming, as far as it was possible, the rich collections that were acquired in various ways. Like W. B. Dalley and William Macleay, he was a Trustee of the Australian Museum during a critical period of its history. No one, therefore, had a better knowledge of William Macleay as a scientific man, both in a private and in an official capacity, than W. J. Stephens.

It is so difficult for one of a later generation to write a worthy appreciation of William Macleay's important contribution to the advancement of Science in this State, because of our imperfect knowledge of the circumstances which inspired it, and led up to its consummation. He was a far-seeing man, of forceful character, of high ideals, doing what he voluntarily did as if from a sense of duty, modestly reticent about himself, and without any inclination to indulge in autobiography. We have no detailed records by himself of his early life, of his Australian experiences as a squatter during an eventful period, or as a Parliamentarian, nor of the awakening of his interest in Science. Particulars respecting the scope and aims of his activities during the first stage of his scientific career have to be gleaned from his printed contributions, or from those of his friends or correspondents. For the second stage only is there any personal record of his own, and this, though hitherto unpublished and important, is not quite as complete as could be wished.

But what can be learned from all available sources of information abundantly shows how earnestly intent he was upon making the most of his opportunities,

and on utilizing his resources wisely for desirable ends, such as initiating new and needed enterprises at favourable times. In trying to realize his aims, without saying so, he was undoubtedly influenced by the example of his distinguished relatives, desirous of upholding the family reputation, and of justifying his accession to the Macleayan succession as, in a special sense, the Australian member thereof. But in his modest way he was content to allow results to speak for him, without commentary of his own. No better illustration of his many admirable characteristics, especially his capacity for inspiring the co-operation of others by giving a lead, and of deservedly becoming the tacitly acknowledged leader, without any evident assumption of leadership on his part, was possible, than was afforded by his never-failing, effective, but unobtrusive service, and his unostentatious liberality to the Linnean Society of New South Wales, from first to last, as the surviving early Members can testify.

Prelude to William Macleay's Australian Career.

Second son of Kenneth Macleay of Keiss (not Kenneth Macleay, antiquarian, of whom a notice is given in the *National Dictionary of Biography*), who married Isabella Horne; born at Wick, June 13th, 1820—Educated at the Edinburgh Academy: medical student at Edinburgh University, but removed to Australia before graduating—1838-39, the family influences which helped him to shape the prelude to his career in Australia—1838, by the advice of his uncle, Alexander Macleay, after the death of his widowed mother, William Macleay decided to emigrate to Australia; accompanied by his brother John, he came out with his cousin, William Sharp Macleay, and James Macarthur, of Camden Park, leaving England on November 11th, 1838; the close companionship with his cousin, and their scientific diversions during the long voyage were responsible for the awakening of William Macleay's interest in Natural History; James Macarthur's non-scientific but still helpful influence on an expectant young squatter—1839, March 10th, arrival in Sydney; personnel of first family gathering assembled at Elizabeth Bay House to welcome the new arrivals.

Events leading up to William Macleay's departure for Australia.—Unless circumstances prevented such an undertaking, Alexander Macleay would certainly have paid a farewell visit to his relatives and friends in Scotland, before leaving England for Australia in August, 1825, for he could hardly have expected to revisit the old land. Even if he did, his visit would have made little permanent impression upon William Macleay, then a child in his sixth year. But after his arrival in Sydney, he evidently kept in touch by correspondence with his Scotch relatives, as he, and other members of the family did, with William Sharp Macleay in Cuba, as well as after the latter's return to England in the autumn of 1836. Knowing that the latter was contemplating a visit to Australia, Alexander Macleay seems to have advised his two nephews, William and John, to come out with their cousin, as the first step to going on the land, leaving it to William Sharp Macleay to arrange the details. As we shall see later this advice proved to be good advice, for it was based on a knowledge of the impetus to settlement, as well as on his own and his son George's experience as farmers and pastoralists of standing. So far as William Macleay is concerned, his acceptance of his uncle's advice was a momentous decision. We may leave John out of account for the present as, though he may have derived some temporary benefit from the sea voyage and a change of climate, his delicate health prematurely blighted his prospects of becoming either a successful squatter or a man of science.

William Sharp Macleay was born in London, educated in England, and his mother was English, so that he was not so directly interested in Scotland as his father. Nevertheless, when the time arrived he was quite ready to take a practical interest in his younger inexperienced Scotch cousins, which was to have important results. No less momentous was William's acceptance of the advice to come out to Australia in the same ship with his cousin, William Sharp Macleay, for it was to be a most eventful voyage.

Unfortunately we have no autobiographical details of the awakening and subsequent development of William Macleay's interest in Natural Science, but a consideration of some now available facts will lead to a fair approximation to the truth. He may possibly have entered upon the study of zoology as a medical student at Edinburgh University. If he had attended the lectures of Professor Jamieson and developed a student's interest in the Professor's museum, that would be something to the good. But the lasting interest in Natural History for its own sake, which bore fruit in later years, was profoundly stimulated, if not actually awakened, by the close companionship with his cousin, William Sharp Macleay, and a share in his scientific diversions on the long voyage from England in a sailing ship, in 1838-39. William Macleay, at this time, was a young man in his nineteenth year, with but little knowledge of the world; whereas his cousin was in his forty-seventh year, a gifted and experienced zoologist, who personally knew many of the eminent biologists of his time (in Paris and London), a voyager who had crossed and re-crossed the Atlantic, after spending ten years of his life in the tropics. We know, from their own records, how only a few years later, William Sharp Macleay was to deserve the gratitude of Assistant-Surgeons T. H. Huxley and J. Denis MacDonald for his kindly encouragement and help in making the most of their scientific opportunities at sea.

It was to be expected of him, therefore, that he should have laid himself out to share his interest in what was to be seen or captured on the voyage, with his two cousins, his own kith and kin, for if they had any latent enthusiasm, or were at all responsive, they could not have had a more inspiring mentor, or a more capable guide, philosopher and friend. The affection which throughout the rest of their intercourse, subsisted between them, and the deference and respect which William Macleay always showed towards his older cousin, go far to establish the belief that the close companionship and influence of William Sharp Macleay on the long voyage to Australia was a very powerful factor in the future scientific career of William Macleay. Direct evidence of this is afforded by a treasured copy of the "Annulosa Javanica", bearing the inscription, "W. Macleay Esq., from his affectionate cousin".

William Sharp Macleay entered upon the voyage prepared to continue the study of Nature at sea which had engaged his attention in crossing and re-crossing the North Atlantic. He brought with him his microscope, apparatus for tow-netting and a supply of books. It was winter in the northern hemisphere when the voyage began, but there would be opportunities for observational zoology. The conditions were more favourable after crossing the equator. One of his sketch-books contains a number of drawings of pelagic Hydrozoa, Crustacea, Pteropoda, Tunicates, an Esocid fish and other organisms taken with the towing net "halfway between Brazil and the Cape of Good Hope", or "off the Cape of Good Hope"; and of a parasitic crustacean found on a shark, with critical notes on some of them. The specimens figured were new or of special interest

to him; but the commoner or better known forms, not figured, would serve to interest his associates, and mitigate the tedium of the long voyage. At least we may be sure that William and some of his companions were not content to be mere unsympathetic lookers-on when the conditions permitted tow-netting.

We know, from their published records, how voyagers to Australia, before and about this time, who were interested in natural history, in the old days of slow sailing ships, like Banks and Solander, Dr. George Bennett, James Backhouse, Charles Darwin, Mrs. Charles Meredith (née Louisa Twamley, authoress of "English Wild Flowers"), fortified themselves against tedium by taking advantage of their opportunities of studying Nature. William Sharp Macleay, on his arrival in Cuba, in December, 1825, sent his friend Vigors in London a long account of his ornithological observations made during the voyage, and at the ports at which the vessel touched.

Mrs. Meredith (1812-95)—née Louisa Anne Twamley, authoress of "English Wild Flowers", illustrated from her own drawings, and other books, published in England before she left for Australia—deserves mention as the writer of "Notes and Sketches of New South Wales during a Residence in that Colony from 1839 to 1843" (a misprint for 1840), published in London in 1844. This little book is an interesting record of the voyage to Australia, of first impressions of Sydney, and of a visit to Bathurst, by an accomplished woman interested in Natural History. The Merediths arrived in Sydney on September 27th, 1839. A fortnight later, they journeyed to Bathurst, where Mrs. Meredith remained for a month, while her husband visited his sheep-station on the Murrumbidgee. Soon after their return to Sydney, in January, 1840, they went to reside at Homebush, formerly the residence of Mr. D'Arcy Wentworth. In October, 1840, they removed to Tasmania, where they resided permanently. Mrs. Meredith, by her sustained efforts to popularize the study of Natural History in Tasmania, well deserved the name of the "Grand Old Lady of Tasmania", by which she came to be known. Among her books, some of them illustrated from her own drawings of plants, animals and scenery, mention may be made of "My Home in Tasmania during a Residence of Nine Years" (2 vols., 1852), "Some of My Bush Friends in Tasmania" (Two Series, 1869-91, with 11 and 12 coloured plates), and "Tasmanian Friends and Foes, Feathered, Finned and Furred" (1881). Mrs. Meredith was here only a short time and resided too far from Sydney to make the acquaintance of the Macleays. But her little book is deserving of notice because it gives particulars of life in Sydney and the country as it was when William Sharp and William Macleay came to Australia.

A more important book descriptive of the progress of British settlement in Australia in the "Thirties", shortly before William Sharp Macleay and his cousins came to Sydney, is "A Narrative of a Visit to the Australian Colonies" (1832-38), by James Backhouse (London, 1843). This book is a most valuable record for the period to which it relates. The visit "was underfaken solely for the purpose of discharging a religious duty", by Mr. Backhouse (1794-1869), and his colleague, Mr. G. W. Walker, under the auspices of the Society of Friends. The two travellers made their philanthropic journeys mostly on foot, and were able to visit a great many settlers in the country, by whom they were hospitably received. Moreover, Mr. Backhouse was an excellent botanist, at the same time not regardless of the fauna, and paid as much attention to natural history as circumstances permitted. I have already quoted from his interesting book in the first part of my Address.

Charles Darwin's brief record of his visits to Sydney and Bathurst, in January, 1836, is also worthy of mention (Naturalist's Voyage Round the World, Chapter xix).

Voyage to Australia and arrival in Sydney.—The published biographical notices of William Macleay, with the exception of the Introduction to the Macleay Memorial Volume, merely state that he arrived in Australia in 1839. It was from Alexander Macleay's entry in his Plant-book, "Plants brought by W. S. Macleay, per *Royal George*, March, 1839", that I first learnt of the arrival in March, though the day of the month is not given. Reference to the files of the newspapers of the period, the *Sydney Herald*, the *Australian*, and the *Sydney Monitor* for the month of March, 1839, revealed the fact that the issues of all three for March 11th record the arrival of the *Royal George* on the previous day, Sunday, March 10th. The three lists of the passengers, however, do not agree in all particulars. As given in the *Herald* and the *Australian*, the list includes only two Macleays, mentioned as Mr. Walter McLeay, and Mr. William McLeay. I, therefore, give the more satisfactory list from the *Monitor*—"Same day (yesterday) the ship *Royal George*, 585 tons, Captain Chaidy (Richards, in the other two and in the manifest) from London, 11th November (1838), via Cape of Good Hope, 25th January (1839), with merchandise. Passengers: J. (James, in the other two) McArthur Esq. and lady, (W.) S. McLeay Esq., Messrs Barnet (Burnett), Surgeon Superintendent Richard Burchell Esq., Dalrymple (George in the other two) Leslie, Watt (omitted, as such, in the other two, apparently mistaken for Walt. and given as the Christian name of the first McLeay to be mentioned), (John) McLeay, Wm. McLeay, Hodgson, Browne (Bouverie in the other two), Isaac, and Stone. Steerage, 102 emigrants with their friends." (The *Herald* gives—"The *Royal George* has brought one hundred emigrants from the agricultural districts, who have arrived in a very healthy condition. There were two births on the voyage, and no deaths.") "March 15th.—The *Royal George* has hauled to Campbell & Co.'s wharf to discharge." "March 18th.—Manifest of the *Royal George* . . . . 3 casks seeds, 21 rams, 18 ewes, C. F. Warne; 1 phaeton, 1 gig, 1 chariot, 1 horse, 1 britska, 2 chests plate, 44 packages, James McArthur; 5 cases marble, 2 cases plants, 37 packages, W. S. McLeay."

This interesting record furnishes an explanation of the two letters of Jany. 7 and July, 1838, from Edward Macarthur to W. S. Macleay already mentioned (Proceedings, 1920, p. 606). Before considering this, some preliminary details will help, because William Macleay's introduction to, and association with, James Macarthur on this eventful voyage, were the beginning of future friendly relations with James and William Macarthur which came about in the fulness of time, in ways that were entirely unforeseen. Two far distant events may be mentioned. About twenty-eight years later the friendly relations between the Macarthurs and the Macleays were enhanced by James and Emily Macarthur becoming the parents-in-law of Arthur Alexander Walton Onslow, grandson of Alexander Macleay. About thirty-six years later Sir William Macarthur was to be chosen as the first Vice-President of the Linnean Society of New South Wales, and Captain Onslow a member of the first Council thereof.

Captain Sturt started from Sydney on his second expedition "down the Murrumbidgee and Murray Rivers" on Nov. 3, 1829. Of the first day's journey he says: "I proceeded direct to the house of my friend, Mr. J. Deas Thomson, who had agreed to accompany me to Brownlow Hill, a property belonging to

Mr. McLeay, the Colonial Secretary, where his son, Mr. George McLeay, was to join the expedition". After a hasty breakfast, he went to the carter's barracks. At 6.45 a.m. the party with drays and pack-horses "filed through the turn pike-gate, and thus commenced its journey with the greatest regularity". Sturt and his companion, after keeping with the party until the junction of the Great South Road with the Great Western Road, four miles from Sydney, pushed on, and reached Brownlow Hill, a fifty-mile ride, about sunset. "The party arrived at Glendarewe, the farm attached to Brownlow Hill, on the 5th." Brownlow Hill and Glendarewe farm comprised the property of 15,000 acres, about 40 miles out of Sydney, purchased by Alexander Macleay soon after his arrival in Sydney, as mentioned in Mrs. Macleay's letter to her eldest son, then in Cuba, written about June, 1827, as already mentioned (PROCEEDINGS, 1920, p. 590). The object of this purchase was to provide a career on the land for his sons, George and James. With the co-operation of a capable overseer they forthwith managed the property.

Among their neighbours at this time were James and William Macarthur, who since 1818 had been assisting their father, Captain John Macarthur of Elizabeth Farm, Parramatta, to improve and manage his property at Camden.

John Macarthur (1767-1834) "who introduced the merino sheep into Australia, and founded the Australian wool trade", and his estimable and capable wife, Elizabeth, were the honoured parents of five sons and three daughters. The eldest son, Edward Macarthur (1787-1872), was born at Bath, England, and came to Sydney in his infancy with his parents in the Second Fleet in June, 1790; he went to England to be educated in 1795 and returned to Sydney in 1806 to visit his parents before entering upon a military career; he served with distinction in the Peninsular War; visited Sydney for the third time for ten months, April, 1824, to February, 1825; served on the staff in Ireland in 1837; came to Australia for the fourth time as Deputy Adjutant-General; in 1855 was Commander-in-Chief of the Forces in Australia; Lieut.-Governor of Victoria, Jan. to Dec., 1856, after the death of Sir Charles Hotham; he rose to the rank of Major General and in 1862 was created K.C.B.; he eventually returned to England. James, second son, died in infancy. John, third son, born at Parramatta, went to England with his father and eldest sister to be educated, 1803; subsequently chose the legal profession, and at the time of his death in 1831, was a rising young equity barrister. James, second of this name (1798-1867), fourth son, and William (1800-82), fifth son, were also born at Parramatta; they accompanied their father to England to be educated in 1809; spent some time with their father in France and Switzerland, and returned to Sydney with him in September, 1817. The following year "James and William, assisted by a gardener . . . . began work at Camden, where but one acre of land was cleared and a small weatherboard cottage built" (Some Early Records of the Macarthurs of Camden, p. 314). Considerable progress had been made at the time of Mrs. Macarthur's visit to Camden in Dec., 1830. I have already given an extract from her letter to her son Edward in England dated from Camden, Dec. 29th, 1830, in which she speaks of the young McLeays, George and James, at Brownlow Hill as very agreeable neighbours of William her youngest son, and of their frequent visits to Camden Park (PROCEEDINGS, 1920, p. 630). James is not mentioned because he was away on his second visit to England, whither he went in 1828 with a shipment of wool, arriving on Sept. 12th, to superintend the sale, and to gain experience

by learning from the wool-buyers what their requirements were, and what they thought of the Camden wool; also to visit wool-growers in Germany and to communicate with the directors of the Australian Agricultural Company. He returned early in 1831, the year of the untimely death of his brother John in London. Their father died at Camden on April 10th, 1834. He had been a Member of the Legislative Council from 1824-33. The new home at Camden was in course of erection at this time but was not completed. Thereafter the entire management of the Camden estate was shared by James and William. There are some interesting records of William for the year 1836. James Backhouse records that on Feb. 24th, 1836, "I spent a few hours with Alexander McLeay, Chief Justice Forbes, Sir John Jamison, William Macarthur, and some other gentlemen, who requested me to join them in examining the fruit of the Vines, of which they have a collection, amounting to about three hundred varieties; they were brought to the Colony by James Busby, from Luxemburg, Montpelier, etc." (Narrative, p. 350). Alexander Macleay's Plant-book shows that before April, 1836, he was exchanging plants with William Macarthur. The announcement of his Excellency the Governor's appointment of the first "Committee of Superintendence of the Australian Museum and Botanical Gardens", dated June 14th, 1836, appeared forthwith in the *Government Gazette*. The first four of the ten names on the list of members are, The Honorable Alexander McLeay Esq., Sir John Jamison, K.G.V., Phillip Parker King Esq., William Macarthur Esq., and the last is George McLeay Esq.

James Backhouse and his colleagues visited George and James Macleay at Brownlow Hill, Oct. 19th-22nd, where on the 20th they met William Macarthur, and accompanied him "to his noble mansion, at Camden, which is of two stories, built of beautiful sandstone and finished in style equal to that of the dwellings of the upper class in England. The gardens are extensive and well laid out. . . . The seasons have latterly been so dry, that not more than 10,000 sheep can now be kept here, where formerly 30,000 were maintained; the flocks have consequently to be driven to the higher lands, to the south, for pasturage". The following day they visited the Camden farm-establishment and "had a meeting with about 100 of the men, who are now busy with the sheep shearing" (Narrative, p. 447).

The new home was now finished, but as Mrs. Macarthur is not mentioned, apparently she had not yet removed from the old home, Elizabeth Farm, Parramatta. James Macarthur too is not mentioned, because in this year, 1836, he visited England for the third time, to convey petitions to the King and Parliament on transportation, immigration, and representative institutions; also to publish his book "New South Wales, its Present State and Future Prospects" (1837); and, as it turned out, to marry Miss Emily Stone, daughter of a London banker (1838). Before leaving for England apparently Alexander or George Macleay or both furnished him with letters of introduction to William Sharp Macleay, whose term of service in Cuba ended in 1836. Soon after William Sharp Macleay's return to London in the autumn of 1836, he made the acquaintance of James, who introduced him to his brother, Major Edward Macarthur, in 1837, who during the early part of the year had served on the staff in Ireland.

William Sharp Macleay was ready to depart for Australia in August, 1838, as we know from his letter to Dr. McClelland (PROCEEDINGS, 1920, p. 606). James Macarthur and his wife were ready about the same time, and the former had

evidently arranged to come out in the same ship with William Sharp Macleay. James had many engagements to occupy his attention, so his brother Edward relieved him of the trouble of looking out for a suitable ship, and in July, 1838, wrote the second of the only two available letters to William Sharp Macleay, probably sent by a messenger—"I believe I have found at length, the sort of ship we want. If you could call upon me tomorrow about eleven, we might talk it over. It is very necessary that your friends should inform you whether they will accompany you, for on the 1st of August the owner of the ship is to have a positive answer from me." The friends referred to, William and John, were not ready to sail so soon.

As I am now able to show that the party came out in the *Royal George*, which sailed from London on November 11th, William Sharp Macleay and James Macarthur must have good naturedly given up the idea of coming by the ship that Edward had found, and delayed their departure for two months, to enable William Sharp Macleay's two cousins to join them. Mrs. James Macarthur would at least be glad of this postponement of the final parting from her relatives.

It was well for William Macleay that he did not miss the opportunity of coming out with William Sharp Macleay and James Macarthur, and several others of his fellow passengers. From what has been said above it is evident that James Macarthur, an Australian by birth, had an unrivalled knowledge of the various aspects of the wool industry. He and his brother William were well acquainted with and had shared their father's efforts to introduce merino sheep and to establish the Australian wool-trade. For about eighteen years, part of the time in co-operation with their father, they had developed and successfully managed the Camden estate. James had not only a producer's knowledge of the wool-industry, but his second and third visits to England provided opportunities of familiarizing himself with the wool-buyers' and manufacturers' side of the industry, as well as of learning much about the Continental producers' flocks and methods. From an expectant squatter's point of view it was a liberal education to make the long voyage in the company of one of the foremost of Australian wool-producers, especially as Warne's consignment of sheep was at hand to suggest critical remarks, and to enable James Macarthur to give some demonstrations.

The voyage to Australia in the *Royal George* also made possible for William Macleay other friendships than those with William Sharp Macleay and James Macarthur. Three of his fellow passengers mentioned in the passenger list, published in the *Monitor*, as Messrs. Leslie, Hodgson, and Isaac, I believe I am correct in identifying as George Leslie, Arthur Hodgson, and Fred Isaac, whose names have been handed on to posterity as successful pioneer squatters on the Darling Downs.

George Leslie was the younger brother of Patrick Leslie, and Miss Leslie, who afterwards married Christopher Rolleston, C.M.G. (1817-88, came to Australia in 1838), twice President of the Royal Society of New South Wales, and Auditor General at the time of his death. The Leslies are said to have been members of an ancient Scottish family dating from the eleventh century. An obituary notice of Mrs. Rolleston appeared in the *Sydney Morning Herald* of Dec. 10th, 1906, a few days after her death, in which reference is made to her brothers as pioneer squatters. The notice concludes thus—"It may be mentioned that Mr. Patrick Leslie was one of the founders of the Union Club,

in conjunction with Sir Arthur Hodgson, Mr. W. (after Sir William) Macleay, Mr. W. H. Suttor, and others. The Club was founded in 1856, and was located in Wynyard-square, in the premises now occupied by the Imperial Hotel."

Interesting particulars respecting the Leslies and Arthur Hodgson (1818-1902) are given in J. F. Campbell's important paper "Discovery and Early Pastoral Settlement of New England" (*Journ. Proc. Roy. Aust. Hist. Soc.*, viii, 1922, pp. 263, 270). From this I quote the following—"Leslie's glowing accounts of the Downs induced several New England squatters to follow his blazed track and settle in that famous region. Foremost among these were Sibley and King of King's Creek or Clifton; Hodgson and Elliot of Eton Vale; John Campbell of Westbrook; and Hughes and Isaac of Gourie. These five stations in 1841, formed the most northerly nucleus of upland pastoral settlement within the New England district as then recognised." (p. 270.)

Captain W. J. Dumaresque was a member of the old Legislative Council from June, 1843; James Macarthur from 1848; George Macleay from 1851; and William Macleay from March, 1855, all four remaining members till the dissolution on Feb. 29th, 1856. James Macarthur, George Macleay, William Macleay and Patrick Leslie were Members of the first Legislative Assembly elected under the Constitution Act, 1856-57. The first three, and Arthur Hodgson (but not P. Leslie, who went to New Zealand in 1857) were Members of the Second Parliament under Responsible Government, 1857-58; and William Macleay and Arthur Hodgson of the Third Parliament, 1858-59. Thereafter William Macleay was a member of the Fourth to Seventh Parliaments inclusive, 1860-74, and Captain Onslow was a member from 1869-1877; A. Hodgson was subsequently a member of the Queensland Legislature, and at one time Premier.

The *Royal George* entered Sydney Heads on Sunday, March 10th, and would anchor in Spring Cove or Watson's Bay for medical inspection. Surgeon Superintendent Burchell was able to report a clean bill of health, so that if the ship arrived early in the day, and the wind was north-east and not southerly, the *Royal George* may have been able to reach an anchorage in Sydney Cove before dark. Whether Alexander Macleay had heard that William Sharp Macleay and his companions were to come by the *Royal George* would depend on circumstances. Their arrival, therefore, may have been expected, or not. Newspaper reporters were able to get their lists of the passengers for insertion in the morrow's issue.

Nearly thirteen years and seven months had passed since William Sharp Macleay parted with his parents and sisters. He left England for Cuba in October, 1825, and they for Australia in the preceding August. The *Sydney Gazette*—then published on Mondays and Thursdays—for Thursday, January 5th, 1826, records that: "On Tuesday last arrived from England the ship *Marquis of Hastings*, Captain Ostler. She left Portsmouth the 24th August and Rio the 2nd of November, and brings 152 male prisoners—not having lost a man on the passage. The guard comprises a detachment of the 57th Regiment, under orders of Ensign Stewart. The Surgeon Superintendent is Dr. Rutherford, R.N." A separate paragraph, without any reference to any other passengers, states: "By the *Marquis of Hastings*, the new Colonial Secretary, Alexander McLeay Esq. has arrived. Mrs. McLeay, with six Daughters, accompanies him." George and James are not mentioned, so that they must have come later, but before 1829.

The personnel of the family gathering at Elizabeth Bay House in honour of the three new arrivals by the *Royal George*, unless circumstances absolutely prevented the attendance of some of them, would probably have been—Alexander Macleay and his wife; Major and Mrs. Innes and their youthful son from Port Macquarie; Captain and Mrs. W. J. Dumaresque and their youthful son from St. Aubin's or Tivoli; William Sharp Macleay, eldest son; George and James, younger sons from Brownlow Hill; William and John, nephews; Arthur Onslow, grandson. Total: father and mother, two married daughters, two sons-in-law; three sons, unmarried; two nephews; and possibly, if two of them were not too young, three grandsons; possibly 15 in all. It must have been a very joyous re-union, but with just a little overshadowing cloud, especially for parents and eldest son, in that in the interval since the parting in England, the death of Fanny Leonora (Mrs. Harington) had finally parted the eldest son and the oldest daughter, who was his "favourite" sister.

The inscriptions on the cenotaph in St. James' Church to the memory of Alexander Macleay and his wife are on the same tablet, that relating to his wife below. This begins—"Eliza—His wife, daughter of James Barclay Esq.—of London—The honored mother of seventeen children—of whom nine survived—To mourn the loss of her constant love—and matronly example.—Born 13th March, 1769, deceased 13th—August 1847—Preceding her husband by a few months—only, after a happy union—of more than fifty years."

Of the nine survivors alluded to (1847) I am able to account for only seven (William Sharp, George, James, Christianne, Margaret, Rosa and Kennethena), and of the remaining eight only one, Mrs. Harington, deceased in 1836.

In the first part of this Address (Proc., 1920, p. 584) I have given an extract from a letter to William Sharp Macleay written about June, 1827, when he was in Cuba, of which a copy was transmitted to me by Dr. Daydon Jackson, by the kind permission of the Council of the Linnean Society of London. After speaking of her husband's periodical visits to a place called Elizabeth Bay where he had a garden in progress, hoped or expected to build a house, was then building stabling, and had already erected a gardener's cottage, the writer continues—"Your sisters are all pretty well just now, though Margaret has lately been very unwell with a severe cold for which she has been bled and blistered. Chris (Christianne Susan, later Mrs. W. J. Dumaresque) too has been coughing a great deal lately. Fanny has had one or two severe." . . . . (the conclusion of the letter is missing).

At the time this now incomplete letter was written the three daughters mentioned were unmarried, and living at home. Fanny (Frances Leonora) died in 1836, and was probably the first to be interred in the family vault in the Camperdown Cemetery. The cenotaph to her memory in St. James' Church, on the south wall, below that to William Sharp Macleay, bears the following inscription below the family coat of arms—"Frances Leonora Harington—Eldest daughter of Alexander and Eliza Macleay—was born ix November MDCCXCIII.—Married to Thomas Cudbert Harington (Under Secretary at the time—xxv June MDCCCXXXVI—And died viii August following—After a brief union—Of six weeks—Endowed with superior talents—Eminent in graceful accomplishments—She, by deliberate preference—Partook sparingly of the pursuits and amusements—Of the Society she was qualified to adorn—And with self-denying, unobtrusive goodness—Devoted her time and faculties—To instruct the poor and

fatherless—In the principles of the doctrine of Christ—And now little children abide in him."

Margaret Macleay (1802-58) married Captain, afterwards Major, Archibald Clunes Innes (1800-57), H.M. 3rd Regiment of Buffs, uncle of Mrs. Boswell (Proc., 1920, p. 583), and brother of George Innes of Bathurst, who with his brother came to Australia in 1823. George Macleay married their sister Barbara in 1842. Major Innes was at Port Macquarie, during at least part of his residence in New South Wales, and lived at Lake Cottage, Lake Innes, seven miles in the country. J. Backhouse has recorded that during his visit to Port Macquarie, in July-August, 1830, on July 31st—"We received a hearty welcome from A. C. Innes, and his wife, son-in-law and daughter of our kind friends Alexander and Elizabeth (Eliza) McLeay of Sydney." On finally parting from them to continue his journey he records, August 14th—"After a solemn parting from our friends at Lake Cottage, with whom we have sympathized in their affliction, by the loss of a beloved sister (Fanny, Mrs. Harington, died August 8th), who devoted herself much to the good of others, we proceeded to Port Macquarie." (Narrative, p. 406.) I am indebted to Mr. C. Hedley for a photograph of the cenotaph to their memory in the old church at Port Macquarie. From this it appears that Major Innes died at Newcastle on August 20th, 1857, aged 57 years; and Mrs. Innes, at Lake Innes on September 7th, 1858, aged 56 years.

Rosa Roberta Macleay, fourth daughter of Alexander Macleay, married Arthur Pooley Onslow, an officer who served in the Indian Civil Service at Madras, on July 17th, 1832. Their eldest son, Arthur Alexander Walton, was born at Trichinopoly on August 2nd, 1833; and in 1838 he came out to stay with his grandfather for about two years, probably to escape from the Indian climate. Consequently he was an inmate of Elizabeth Bay House, when William Sharp Macleay and his cousins arrived. He returned to England to be educated preparatory to entering the Royal Navy, in charge of Mrs. Dumaresque, widow of Colonel Henry Dumaresque, in 1841.

Mrs. Boswell notes in her Journal, Nov. 29th, 1847—"My uncle is still away, and my aunt speaks of spending Christmas in Sydney, which I hope they may all do, otherwise they will not see the Dumaresq boys, who go to England in the *Agincourt*. Mrs. Onslow, too, will not be remaining much longer in this country, and she is taking her eldest daughter, Georgy, away with her" (p. 134).

From Mrs. Boswell's Reminiscences we learn that on January 10th, 1848, Major and Mrs. Innes and their children left Port Macquarie to spend three months in Sydney, partly for a holiday, and partly to meet Mr. and Mrs. Onslow and their younger children from India, who were also visiting Sydney.

On March 5th, 1848, Mrs. Boswell notes that "our party are still all at Brownlow Hill". The party returned on April 27th, 1848, bringing Mr. Onslow with them, by the Clarence River steamer, which in consequence of unfavourable conditions of the bar at the entrance to Port Macquarie was unable to land passengers for the Port on the outward journey, but after being carried on to the Clarence they were safely landed on the return journey. On May 4th Mr. Onslow started for Sydney overland, that is as far as Raymond Terrace, Newcastle. Mrs. Boswell adds—"He had promised to return and bring his family here at the end of the month, if he can get a steamer to call at Port Macquarie with them, and if they come, Miss Macleay (Kennathena) will come with them. I may here say that Mr. Onslow did not succeed in getting a steamer going north

to call and land passengers at Port Macquarie, as it involved also calling for them. So they all went back to India without our seeing any of them again" (p. 145).

It is of interest to us that Arthur Onslow was an inmate of Elizabeth Bay House, at the time William Sharp Macleay arrived in 1839, and for some time after. He entered the Navy in May, 1847, and after ten years' very interesting experiences, in March, 1857, he came out in H.M.S. *Iris* bound for Sydney to join H.M.S. *Herald*, surveying vessel on the Australian station, in command of Captain Denham. The *Herald* returned to England in 1861 and was paid off. After additional service, Lieutenant Onslow was promoted to Commander in 1863. Shortly after, his health broke down, and he returned to Sydney on two years' sick leave, and apparently did not return to active service. In April, 1871, he was placed on the retired list, and promoted to the rank of Post Captain. Meantime, Commander Onslow married the daughter of James Macarthur of Camden in 1867; and was elected to the Legislative Assembly as the Member for Camden in January, 1870. When Lieutenant Onslow joined H.M.S. *Herald*, he had for his colleagues, among others, Surgeon Rayner, and Assistant-Surgeon J. Denis Macdonald, who were friends of William Sharp Macleay before Lieutenant Onslow arrived, as narrated in the first part of this Address (PROC., 1920, pp. 616-17). The addition of a relative to the official staff of the *Herald* from 1857 to the termination of her commission on the Australian station, early in 1861, would add to William Sharp Macleay's interest in the work of the ship. During his service in H.M.S. *Herald* Lieutenant Onslow seems to have become interested in Natural History, especially in conchology. His first appointment afloat, after his return to England in 1861, was to H.M.S. *Phaeton*, and he was at Vera Cruz during the French operations at Mexico.

After the second of his two expeditions down the Murrumbidgee, etc., in 1829-30, Captain Sturt (1795-1869) sailed for Norfolk Island in command of a detachment of soldiers in 1830, where, shortly after, he met Allan Cunningham. But ill health, including threatened blindness, caused his return to Sydney in January, 1832, after about eighteen months' service. Soon after he departed for England on sick leave to supervise the publication of his first book, "Two Expeditions, etc." He was married one week before embarking on the return voyage to Sydney, on September 30th, 1834. The happy couple arrived in Sydney about March, 1835 (the exact date not given). His biographer says, concerning this second visit to Australia—"The young wife was deeply impressed by the approach to Sydney. . . . Sturt left his wife on board the ship (in which they had arrived) while he went to the Macleays' fine house near the harbour. Presently Mrs. Sturt saw him return in a well-appointed boat, rowed by two stalwart men dressed as sailors. Her husband told her these boatmen and most of the men she would now see were convicts, and that it was important not to make any remark likely to hurt their feelings. The kind Macleays (George and James) welcomed the Sturts most warmly to their paradise of Brownlow Hill. The young settlers however soon took up their abode in a pretty cottage in the outskirts of Sydney, whence Sturt made many long bush journeys in his search for a promising allotment." (p. 112.) Thereafter, in the same year, 1835, Sturt settled first at Bargo Brush or Mittagong; in 1837, removed to Varroville, near Liverpool, which was his home until he left New South Wales for good, to reside in Adelaide, on his appointment as Surveyor General of South

Australia. He returned to England early in 1847 on leave of absence; reached Adelaide again in August, 1849; was appointed Colonial Secretary; retired in December, 1851, in fear of blindness, and received a pension; and sailed for England on March 27th, 1853, "to save (money) and educate his boys; and to reside there for the rest of his life". In a letter to George Macleay, dated from Adelaide, May 19th, 1852, giving an account of his retirement, and of the death of his mother, and other family news, he adds—"Remember me kindly to Deas-Thomson. Remember me, too, to William McArthur and James, and say I do not forget old times. Remember me also to (Captain William) Dumaresq and his wife" (p. 296).

Sturt's biographer (apparently his daughter-in-law, Mrs. Napier George Sturt, wife of Colonel Napier George Sturt, R.E.), I think, had no opportunity of visiting Australia, so that the error I am about to point out, is excusable. The statement that, about March, 1835, "Sturt left his wife on board the ship, while he went to the MacLeays' fine house near the harbour. Presently Mrs. Sturt saw him return in a well appointed boat, etc.", needs amendment. In March, 1835, Alexander Macleay was still Colonial Secretary (retired in January, 1837), occupying the official residence in Bridge Street. There was a garden, stable and gardener's cottage, but Elizabeth Bay House was not then built, and when built was not ready for occupation until about April, 1837. Apparently what happened was that, when the ship was at anchor in or off Sydney Cove, Sturt went ashore, perhaps in the ship's boat with other passengers, landed at what is now Circular Quay, about five minutes' walk from the Colonial Secretary's office, to pay his respects and report his arrival; then perhaps he went to the private residence in Bridge Street. "Presently" he returned to the ship in a hired boat.

Sturt's letter to George Macleay, from Adelaide, dated May 19th, 1852, ends with the request—"Remember me kindly to (J.) Deas-Thomson (who accompanied him on the first stage of his Second Expedition, Sydney to Brownlow Hill, Nov. 3, 1829; son of E. Deas-Thomson, successor to A. Macleay). Remember me, too, to William McArthur and James, and say I do not forget old times. Remember me also to Dumaresq and his wife." This refers to George's brother-in-law, Captain William John Dumaresque, the younger brother of Lieutenant-Colonel Henry Dumaresque, who arrived in October, 1825, being the first member of the Dumaresque family to come to New South Wales. At the time of his death at Port Stephens on May 3rd, 1838, Henry Dumaresque was First (that is Chief) Commissioner of the Australian Agricultural Company, and the successor of Sir Edward Parry, whose name is commemorated by *Macropus parryi*, a handsome wallaby which he brought to the notice of its describer. The New South Wales Calendar and General Post Office Directory for 1832, gives his address as "St. Helier's, Alcorn's Inn" (then a postal town in the Hunter River District, with a weekly mail, 137 miles from Sydney, 10 miles from Maitland), and his brother William's as "ditto". James Backhouse's Narrative records, June 25th, 1836—"Near this place (Muscle Brook, now Muswellbrook) we came again upon the rich, alluvial soil of the Hunter, and a few miles further, reached Arthur's Vale, a large farming establishment, belonging to Henry Dumaresq (evidently absent at the time at Port Stephens), by whom we had been recommended to the kind notice of his agent. . . . June 27th. We proceeded to St. Aubin's, the residence of William Dumaresq, from whom we received a most kind welcome. This establishment is conducted on a similar plan to that at Arthur's Vale, and

with similarly beneficial results." Compared with the reference to the Inneses, this is a bachelor's reception. Apparently William Dumaresque had acquired an estate of his own, and probably about this time, October 22nd, 1830, married a daughter (Chris of her mother's letter to William Sharp Macleay) of Alexander Macleay's. June 29th, 1836—"Not apprehending it to be our duty to proceed further in this direction (Mount Wingen or the Burning Hill, a pseudo-volcano, distant about 14 miles from St. Aubin's), we returned by way of Henry Dumaresq's house at St. Hellier's to Arthur's Vale", and thence on to Maitland. From Maitland they proceeded via Morpeth, Raymond Terrace, Sawyer's Point, to Port Stephens where, on July 12th, "a boat, belonging to the Australian Agricultural Company, conveyed us from Sawyer's Point, on the south-west of the estuary of Port Stephens, to Tarlee (Tahlee) House, the residence of Henry Dumaresq, the Company's First (that is Chief, not in time or order), by whose family we were received with much Christian kindness" (p. 399). All this happened about a month before the visit to Port Macquarie and to Major Innes and his wife, as narrated above.

William John Dumaresque came out as a member of the suite of his brother-in-law, Governor Darling, arriving in Sydney on December 22nd, 1825, and subsequently took charge of the Public Works Department, as Inspector of Roads and Bridges. "He retired from the service in 1829, and settled on his grant of 2,500 acres, St. Aubin's in the Hunter Valley. To this grant had been added his wife's dower grant, 'according to the custom of the time' ". On 22nd October, 1830, he married Christianne Susan, the daughter of Alexander Macleay. As there is no reference at all to her, such as there is to Mrs. Innes, Mrs. Dumaresque may have been away from home at the time of J. Backhouse's visit to St. Aubin's. The family comprised—William Alexander, B.A. Cantab. (went to England to be educated, perhaps to enter the army, but returned to Australia to become a squatter, first at Scone in the Glen Innes District, later on a friend of William Macleay and guest at Elizabeth Bay House, especially in 1874)—Alexander M., Captain, 63rd Regiment (apparently did not return to Australia)—Elizabeth Ann, died young—Susan Frances Sophia, married in October, 1859, to the Hon. Louis Hope, of Queensland (later on the friend of William Macleay, and a guest at Elizabeth Bay House during the Garden Palace Exhibition in 1880)—and Eliza Henrietta. Before 1848, Captain Dumaresque had a home at "Tivoli", Rose Bay, where Alexander Macleay died on July 19th, in his 82nd year. At this time the latter was a widower, and William Sharp Macleay was a bachelor. After his accident, by his own request, he was taken to "Tivoli", that he might have the womanly ministrations of his nearest female relative in what, he must have suspected, would be his last illness. His son-in-law died a little over twenty years later. The cenotaph to his memory in St. James' Church, King Street, bears the following inscription, below a medallion—"William John Dumaresque—Captn. Royal Staff Corps—Served in the Peninsula, and Canada, and New South Wales—Born xxv February MDCCXCII., died in November MDCCCLXVIII." The tomb or vault in the old Camperdown Cemetery is close to that of the Macleay family. But both vaults bear only the surnames Macleay, Harington in one case, and Dumaresque in the other, so that one cannot tell who were buried therein, unless there happen to be cenotaphs in St. James. As there is not one to the memory of Mrs. W. J. Dumaresque, I do not know when she died.

William Alexander Dumaresque, eldest son, is of special interest to us. He was married to Miss Gladstone, sister of Lady Belmore, wife of the Earl

of Belmore, Governor of New South Wales (January 8th, 1868, to February 22nd, 1872). At this time he was the owner of Furracabad, a well known station in the Glen Innes District. The jubilee of the district was celebrated November 1-5, 1922. A small volume entitled "In the Land of the Beardies" (hirsutely speaking, as the pioneers in the old days had no time or inclination to shave) was issued in connection with the celebrations. This contains an attractive portrait of W. A. Dumaresque. His eldest son, John Saumarez Dumaresque (1873-1922), born at Glen Innes, is well known to us as the late Commodore of H.M. Australian Navy; he did us the honour of being present at the Centenary Meeting as one of the two guests of the evening.

William Macleay's Australian Career.

First Period, 1839-57.

The transition from "New Chum" to practical Squatter (managing the station in which he was interested), Member of Parliament, Field Naturalist (with something more than a mere sportsman's interest in the fauna), and "Benedict" with his home in Sydney.—1839-54: Family influences again helpful; by the advice and with the help of his uncle and his cousin George, both squatters, William Macleay became a successful squatter on the Lower Murrumbidgee.—1855: Elected to the old Legislative Council as Member for the Pastoral Districts of Lachlan and Lower Darling.—1856: Elected to the first Legislative Assembly under Responsible Government opened on May 22nd.—1859-74: Member for the Murrumbidgee, in succession to George Macleay.—1856: First record of a reviving interest in Natural Science, his election to membership of the Philosophical Society of New South Wales, at the fourth meeting on August 16th.—1857: His marriage to Miss Susan Emmeline Deas-Thomson, second daughter of the Hon. Edward Deas-Thomson, on June 25th; thereafter resident in Sydney, first at Denison House, Phillip Street, afterwards at 153 Macquarie Street.—Again and henceforth, in close touch with, and under the scientific influence of William Sharp Macleay.

Soon after his arrival in Sydney, in March, 1839, William Macleay entered upon the serious business of life as a squatter, without any previous experience to guide him, under conditions that were altogether new and in a very remote district of New South Wales. All that is said of this enterprise in the first of the biographical notices mentioned above, is the brief statement—"In 1839 he came to Sydney, to his uncle Alexander Macleay Esq., then Colonial Secretary; passed the first fifteen years in squatting pursuits on the Murrumbidgee."

The period of upwards of fifteen years, from 1839-55, especially 1854, is that of which we know least, partly because no autobiographical records are available, and partly because in these early pioneering days settlement on the Lower Murrumbidgee was so scattered that things were not sufficiently advanced to find a record in the then current Almanacs or Directories published in Sydney.

John Macleay's delicate health, and premature death, deprived him of the chance of becoming either a squatter or a man of science. Soon after his arrival he visited his cousin Mrs. Innes, wife of Major Innes at Port Macquarie. Mrs. Boswell, then Miss Innes, a girl about nineteen years old, in her "Recollections" thus refers to John—"That autumn (1846) Mr. John Macleay, a cousin of my aunt's, came to stay at the Lake (Innes). He was very delicate, and it was hoped that his health would improve in the fine air and pleasant surroundings. Unfortunately this hope was not realised, and, as a sea-voyage was recommended,

he sailed for London. Our friend, Mr. Gunn, went with him. Poor Mr. Macleay died during the voyage. We were all sorry. He had interested us greatly; he was so gentle and handsome. I spent many an hour reading aloud to him" (p. 107).

When the celebrations were over and William Macleay had seen all there was to see in Sydney—and what this amounted to is suggested by the narratives of Charles Darwin, J. Backhouse, for Sydney, in 1836; and the interesting experience of Mrs. Owen Meredith in 1839-40—including perhaps inspections of the Macleay Collection and Australian Museum, possibly also visits to Botany Bay, La Perouse's Monument and Parramatta, he would begin to think about the future, and how he was to become a squatter. He would see for himself or at least hear that, when he arrived, a drought prevailed. But his uncle and George could tell him that they, too, arrived in Sydney in January, 1826, in a time of very severe drought. Also they could assure him that, though droughts occurred periodically, in due time they broke up. They would relate their experiences as squatters and would advise him to visit the back blocks of the Murrumbidgee, prospecting for a location that would suit him.

As in Sturt's case, when starting from Sydney on his second expedition, the first day's journey would be via the "Great South Road (which) on the left, leaves the Parramatta Road at Speed the Plough Inn, 5¼ miles" (in 1832, as also doubtless in 1839) via Lansdown Bridge.

We do not know what actually happened, but upon all the evidence available, what I have to say about it is a natural, not to say a logical, conclusion from the circumstances of the case. William Macleay was a stranger, but a relative, and blood is thicker than water. He had come to Australia by the advice of his uncle. It was now up to his uncle to justify his advice, and doubtless, with George to back him up, he was ready to do so. What conclusion could they come to other than that, as soon as convenient, William, under George's guidance should make a pilgrimage to George's station, Toganmain, on the Lower Murrumbidgee, not only to gain some experience, but to make use of Toganmain as a base for spying out the land before deciding upon the next step to be taken. The importance of this conclusion will be more appreciable if we first consider how it came about that, before 1838, George had a station on the Lower Murrumbidgee.

George Macleay was born in 1809, but I do not know the month. His association with Sturt on the latter's second expedition came about in quite a casual and unexpected way. Hume accompanied Sturt on his first expedition to the Darling, and Sturt hoped to have him again as a second in command on the second expedition. But harvest-time was approaching, and Hume felt that he could not afford to run any risk of not getting the full measure of the harvest. Therefore he reluctantly declined his old leader's offer. Sturt then asked George Macleay to accompany him, not as a paid assistant, but as companion. George Macleay accepted the invitation, entered upon his duties in November, 1829, early in his twenty-first year, amply justified his leader's expectations of him, and thereafter became a fast friend. Since both Hume and George Macleay proved to be capable, trusty sub-leaders, always ready to back up their leader, it is obvious that it was immaterial to Sturt which of the two accompanied him on the second occasion. But to George Macleay, his association with Sturt on this eventful journey was one of the great events of his life, and of fruitful

and outstanding importance. When he accepted Sturt's offer he was a minor, engaged, with his brother, in managing his father's farm and garden at Brownlow Hill, getting a salary with probably a percentage on results. His father and William Sharp Macleay had served their country in important official positions for long and critical periods. When the time for retirement came, they retired, with a letter of thanks and a pension, but without any titular distinction. George never at any time occupied any permanent official position. He was a Member of Parliament for some years at a time when payment to members had not come into vogue, but never a Minister of the Crown. But he had accompanied Sturt on his second "Expedition down the Morumbidgee and Murray Rivers, 1829-30". On the return journey, Sturt notes that, before the rest of the party reached Pondebadgery (Wantabadgery) on April 28th, 1830—"I had sent McLeay forward (to Sydney) on the 20th with letters to the Governor (Gipps), whose anxiety was great on our account". George delivered his despatches in Sydney on or about May 10th. Sturt arrived on May 25th. When George Macleay started on his long ride back to Sydney, apparently alone, he did not know that he was already a potential squatter on the Lower Murrumbidgee, still less did he know, what was much farther ahead, namely that he was potentially a C.M.G., and later K.C.M.G., primarily because he had been Sturt's companion on the latter's second expedition. The explanation of the statement that on his ride to Sydney he was already a potential squatter on the Lower Murrumbidgee is that in due time the Government decided to recompense him for his honorary services to Sturt by offering him a grant of 1,280 acres of land.

At the outset of his career I believe that William Macleay's station on the Lower Murrumbidgee, known afterwards, but not at this time, as Kerarbury, was entirely his own venture. Waugh's Australian Almanac for 1855, contains a list of the magistrates or J's.P. of the Colony, which includes the names of "Macleay, George, Murrumbidgee" and "Macleay, William, Murrumbidgee" (that is the pastoral district). Their names are included because they were squatters in the Murrumbidgee District, George at Toganmain, and William at what was known afterwards as Kerarbury. But the record in the next volume for 1856 is most enlightening. George's name is omitted, suggesting that he had parted with Toganmain in 1855. But the record for the previous year, 1855, is (the names in alphabetical order; I have included only names of interest to us)—"Clarke (should be Clark), Walter (Karrabung)—Gordon, John (Borambullah)—Macleay, William (Karrabory)—Macleay, Alex. D. (Karrabory)—Peters, John (Gumly Gumly)". This is the only list in all the series of volumes available which gives the station-addresses, all, it will be noticed, aboriginal names or as nearly as those who desired to use them could transcribe. It is therefore most helpful. From this we learn (1) that the original name of William Macleay's station was Karrabory; (2) that, in 1856, because he had been isolated in the bush for fifteen years and because he wanted assistance and more capital to develop the station, his brother, Alexander Donald Macleay (always called Alick in William's Journal) had joined him as his partner in Karrabory; (3) that Walter Clark had a station, Karrabung, evidently adjoining or contiguous to Karrabory. From documentary evidence I know that soon after this, Clark joined the two Macleays as a partner. They then appear to have consolidated the two stations, and as Karrabory was rather a barbaric name, and Karrabung was no better, perhaps it occured to one of them that Kerarbury was more euphonious.

Haynes John Peters was the young Scotchman referred to in Mr. Justice Therry's book, who came out in 1832, and thereafter for fifteen years successfully managed Alexander Macleay's stations, first at Crookwell, and then at Borambulah, afterwards changed to Borambola, neither name mentioned in Peters' narrative. There is now a railway-station bearing the latter name, evidently on part of the old station, on the Wagga-Tumberumba branch line. Soon after leaving Alexander Macleay's service in 1847, according to J. Gormley, he subsequently married Mrs. Bourke, widow, of Gumly Gumly. John Gordon was manager of Toganmain for George Macleay. After his father's death in 1848, George inherited Borambola and Pulletop, a back-station on Pulletop Creek, a tributary of the Tumut River. George subsequently sold both properties to Gordon. In the above list his name appears as the then owner of Borambola, before the original name had been changed. Gormley records that Gordon told him that in 1838 when he was taking a large draft of sheep from Borambola to Toganmain, about 160 miles lower down the Murrumbidgee, he camped for the night on what was afterwards the site of the town of Wagga Wagga, nine years before the first hut was built.

Kerarbury was sold in 1888. Between 1862 and 1888, Walter Clark died. At the time of the sale the partners were William Macleay, his brother, A. D. Macleay, and John Kerr Clark, either as the trustee of Walter Clark's estate, or perhaps as the purchaser of Walter Clark's interest. I do not know when Alick came out to Australia, whether he resided on the station or had a home in Sydney, nor when he returned to England. I have a letter from him dated from Algiers, 1887, in reply to one from William about the suggested sale of the station, in which he says that with the help of the British Consul he was forwarding a power of attorney, and that he hoped to leave before the end of the month. But I do not think that he came, perhaps in response to a cable.

I have failed to find any corroboration of all the details of (1) the statement in the Hon. W. A. Brodribb's book "Recollections of an Australian Squatter or Leaves from my Journal" (1835), that William and John Macleay, nephews of the late Colonial Secretary, formed a station, quoted by me in the Introduction to the Macleay Memorial Volume (p. xiv); or in my own that William and John engaged in squatting pursuits, first in the Fish River District near Goulburn, afterwards in the Lachlan and Murrumbidgee District, a statement based, I think, on what Mr. Brodribb has to say, and (3) Mr. Brodribb's statement at the lunch given by William Macleay on the occasion of the opening of the Linnean Hall on October 31st, 1885, to the effect that "He came here years ago quite a young man, and embarked in pastoral pursuits—first on the Lachlan, subsequently on the Murrumbidgee River."

John may perhaps, with William, have managed to get as far inland as Alexander Macleay's station at Crookwell; but his health did not permit of his engaging in squatting. The partners in Kerarbury may at some time have had a back-station on the Lachlan. But from all that I have been able to glean during the last thirty years, and from William Macleay's statement, "I resided for many years on the banks of the Murrumbidgee", I cannot avoid the conclusion that his primary, if not his only, interest in stations, or in establishing a station, was his ownership, or his partnership with others, of Kerarbury, with perhaps an unimportant back-station on the Lachlan, of which there is no mention in the prospectus prepared for the contemplated sale of Kerarbury. In other words, that his personal experience as a squatter was entirely confined to what he learnt

either as sole owner, at first when it needed developing, or as a partner in Kerarbury.

No autobiographical details of William Macleay's experiences during the first fifteen years are available. His only record bearing on the subject is given at the end of a paper read at a meeting of this Society on June 24th, 1885, in which he described two new species of freshwater fishes from the Upper Murrumbidgee, specimens of which had been sent to him by Mr. C. Jenkins, of Yass. One of these was referable to Castelnau's genus *Murrayia*, based on the study of three species from the Murray River or some of its anabranches. William Macleay after describing *M. jenkinsi*, n. sp., adds the statement—"the fish I have now described is the only one of the genus I have seen, although I resided for many years on the banks of the Murrumbidgee" (PROC., Vol. x, p. 269).

His continuous residence on the banks of the Murrumbidgee, save for occasional holiday or business visit to Sydney, lasted from the last quarter of 1839 or early in 1840 till his first election to Parliament in 1855. During this period he could not have seen very much of his uncle, who died in 1848. But that did not matter, because George Macleay soon became his guide and helper. Thereafter, up to about the time of his marriage in May, 1857, and his permanent residence in Sydney, he may have spent so much of his time in the metropolis as his Parliamentary duties allowed, returning to Kerarbury for the rest of the year or perhaps for an occasional visit.

The most important available sources of information concerning the early settlement of the valley of the Murrumbidgee, including references to the experiences of the Macleays are:

(1) "Reminiscences of Thirty Years' Residence (1829-59) in New South Wales and Victoria", by R. Therry, late one of the Judges of the Supreme Court of New South Wales (London, 1863).

Mr. Justice Therry has included in Chapter xv of his book (p. 259) the personal narrative of a prosperous squatter (name not disclosed, but evidently John Peters, often mentioned in Gormley's contributions) who came to Sydney from Scotland as a young man in 1832; and, impressed by "the kind and fatherly advice I received from Mr. (A.) McLeay, coupled with the high estimation in which he was universally held" became manager of one or other of Alexander Macleay's stations, first at Crookwell, between Goulburn and Yass, with 2,000 sheep; and then at Borambola on the Upper Murrumbidgee, between Gundagai and Wagga, with 30,000 sheep, and continued to act very successfully for fifteen years. Thereafter he became a squatter on his own account, with 1,000 picked ewes presented to him by Alexander Macleay "as a proof of his appreciation of the judicious manner in which I had managed his flocks." This interesting narrative incidentally mentions most of the troubles of the squatter in those early days.

(2) A short paper entitled "Exploration and Settlement on the Murray and Murrumbidgee", by James Gormley, M.L.C. (*Journ. Proc. Aust. Hist. Soc.*, Vol. ii, Pt. 2, p. 34. Read July 24th, 1906, but not published until 1909), from which some idea of the isolation of squatters and of the droughts and floods they experienced in the remote districts of the Lower Murrumbidgee in William Macleay's day, and of their difficulties in getting supplies from Sydney, in sending sheep and stock to market, and wool to the port of shipment may be gleaned.

(3) Three series of articles embodying the same author's "Reminiscences", contributed to the newspapers at Gundagai, Wagga and Albury, 1915-16, a short time before the author's death. A collection of the newspaper cuttings of these articles, bound in 3 volumes, is contained in the Mitchell Library. Some of these articles are included in "Exploration and Settlement in Australia", by the Hon. James Gormley, M.L.C. (Ford, Sydney, 1921).

Mr. Gormley's first paper, written after sixty-two years' residence on the Murrumbidgee, gives particulars of Alexander Macleay's station at Borambola, and a "back station", Pulletop, which George Macleay subsequently inherited, and George's station Toganmain, about 160 miles lower down the river. But there is no mention of William Macleay, apparently because he was one of "the many others" of whom the author says "I could mention many others, if I had space, who occupied stations down the river on the north side". In the later "Reminiscences" he gives some very interesting references to all three of the Macleays. J. Gormley, born in 1836, arrived in Sydney with his parents in 1840, assisted his father to drive stock from Illawarra to the Murrumbidgee towards the end of 1844, where his father settled near Gundagai, then the only town on the Murrumbidgee on the overland track from Sydney to Port Phillip, comprising about a dozen wooden houses, including a general store kept by Dr. R. Davison from 1841 onwards, probably then the only one between Yass and Melbourne.

Gormley's references to William Macleay are contained in Vol. ii of the newspaper cuttings. The author says—"William and George Macleay were cousins and held the adjoining stations on the Lower Murrumbidgee." The author continues—"William Macleay without contest held the Murrumbidgee seat in five Parliaments, which gave him the record of being in the first seven Parliaments under Responsible Government. . . . William Macleay was associated with the town of Wagga from its earliest days (1847). When travelling from Sydney to Kerarbury Station, which was owned by himself and his brothers, he usually made a stay in Wagga."

The author continues—"William Macleay established the first newspaper, *The Express*, which was published and conducted by a man named Brown, who was afterwards engaged in the Government Printing Office in Sydney. William Macleay was a man of considerable ability; and as a politician always took an independent (stand). He took a keen interest in the progress of the electorate, and purchased land and planted a vineyard at Lake Albert. By his will he bequeathed a considerable part of his fortune to worthy public objects."

Mr. Gormley, in addition to carrying out mail-contracts for a number of years, was also a politician; he was a member of eight Parliaments, and afterwards a member of the Upper House.

In 1855, William Macleay was elected to Parliament, as Member for the Lachlan and Lower Darling in the old Legislative Council; and, on the inauguration of the New Constitution in 1856, he continued to represent the same electorate in the Legislative Assembly, until the removal of George Macleay to England in 1859, when William Macleay succeeded him as Member for the Murrumbidgee. On the dissolution of Parliament in 1874, he did not again offer himself as a candidate, as he was desirous of devoting more time to natural history and the development of his museum. During his twenty years of political life he held

his seat in seven consecutive Parliaments. He was appointed to the Legislative Council in 1875.

Sir Henry Parkes, Premier in 1887, conceived the happy idea of inviting the surviving Members of the first Legislative Assembly under the Constitution Act, opened May 22nd, 1856, to a commemorative dinner on May 23rd, to mark the thirty-first anniversary of Parliamentary Government. Sixty-two Members sat in the first Legislative Assembly, of whom twenty-one survived in 1887. Twelve attended the dinner. Nine, of whom three, including Sir George Macleay, were in England, were unable to be present. Among the memorials of William Macleay is a letter to him from Sir Henry Parkes, dated May 16th, 1887, asking him to speak to one of the toasts. The letter concludes with the sentiment—"I think you will agree with me that the occasion will be one of historic interest". A booklet containing the speeches, a group-photograph of the Members who participated, together with Press notices of the historic gathering, was issued soon after. We have a copy of this also. The group-portrait includes, among others, Sir Henry Parkes, Sir William Manning, the Hon. William Macleay, the Right Hon. W. B. Dalley, Sir John Robertson and the Hon. Sir John Hay. This group-portrait is of interest to us as a Society, because, besides William Macleay, both Mr. Dalley and Sir John Hay were Original Members of the Society; both were present on the occasion of the dedication of the Hall at Elizabeth Bay by William Macleay, for the use of the Society, on October 31st, 1885; and each of them delivered a speech.

William Macleay's election to the Legislature in 1855 necessitated his residence in Sydney during at least part of each year, while Parliament was in session. This also provided an opportunity of intermittently getting into touch again with William Sharp Macleay, and of seeing more of him than had previously been possible. About three years later, in June, 1857, he married Miss Susan Emmeline Deas-Thomson, second daughter of the Hon., afterwards Sir, Edward Deas-Thomson; and thereafter Sydney became his permanent home. He had now time to develop his scientific interests. In the year following, 1858, he set about beginning his collection, which fifteen years later amounted to 320 drawers. But even before he came to reside permanently in Sydney, there is evidence of his awakening interest in natural history.

William Macleay's residence in the country provided him with observational opportunities of learning something about the Blacks, and the conspicuous members of the fauna, such as the marsupials, birds, reptiles and fishes. He would probably have been shown Alexander Macleay's collection soon after his arrival in Sydney, and have helped William Sharp Macleay to unpack his collection and put it in order after the voyage. He might have been asked to collect insects for his relatives. On his occasional visits to Sydney, he would be able to report progress. William Sharp Macleay soon realized how little was known of the Australian fauna as a whole, for in his paper on Dr. Stuart's *Antechinus*, previously mentioned, dated Elizabeth Bay, August 9th, 1841, he says —"During a residence of two years in this colony, the experience of each day shows me that as yet but little is known of the productions of New Holland. The natural history of the interior of this vast island may be considered as altogether unknown; and with respect to the coast, we can only be said to be in considerable degree acquainted with the birds and phaenogamous plants of certain of its particular districts." It is reasonable to suppose, therefore, that

he would encourage his cousin, if he needed it, not only to cultivate the seeing eye and understanding mind, but also to make observations, for him at any rate, and to collect insects if nothing more.

Second Period, 1858-73.

The transition from squatter (sleeping partner) and Member of Parliament to entomologist with his own collection and, from 1865, the last male representative of the family name resident in Australia, with very favourable opportunities, which he did not fail to appreciate, of emulating his scientific predecessors and of upholding and enhancing the family reputation and traditions, the scientific successor to Alexander and William Sharp Macleay (whose joint collection he inherited), the occupant of Elizabeth Bay House.—1858: The beginning of William Macleay's active interest in entomology, with the encouragement and help of William Sharp Macleay.—The Elizabeth Bay property entailed; George Macleay, William Sharp Macleay's next of kin, having no inclination to become an entomologist, decided to return to England and settle there; his departure, in February, 1859, opened the way for William to become the prospective and eventual successor to the joint collections, and to the tenancy of Elizabeth Bay House.—1861: William Macleay elected to the Board of Trustees of the Australian Museum.—1862: William Sharp Macleay resigned from the Board, after twenty years' membership, on account of his steadily declining health; William decided to originate the Entomological Society of New South Wales, while his cousin was still alive and with his approval and support.—1865: William Sharp Macleay's death, on January 26th; William Macleay inherited the joint collection of his uncle and cousin; and after the renovation of the old house became its occupant for the rest of his life.—1869: The Entomological Society came to an end; the history of William Macleay's own collection, as gleaned from the Transactions of the Society.—1873: William Macleay's private offer to the Senate of the University to bequeath his library and the Macleay Collections contained in 800 drawers containing insects and marine invertebrates, with future possible additions to enable it to have an Academic Museum.

An enlightening clue to the significance of the date of the commencement of this period is afforded by a statement in a letter to the Senate, written towards the end of the year 1873, in which William Macleay offered to bequeath the Macleay Collections, together with his scientific library, to the University. In this, he said—"The collection which I have myself accumulated during the last fifteen years, is, as far as Australian insects are concerned, the best I know" (Barff's "A Short Historical Account of the University of Sydney", 1902, p. 120). Here, then, is his own testimony to the fact, that he began in earnest to acquire a collection of his own in or about the year 1858; and that, in 1873, it was the best collection of Australian insects known to him.

The next question is, what were the favouring circumstances in the year 1858 that led up to this determination? Suggestive clues indicate that about this time, a combination of favourable conditions offered incentives to him to make a start as a collector, and to improve his scientific library.

The most important provocations to action were—(1) William Macleay's permanent residence in Sydney; the resumption of his intercourse with William Sharp Macleay; and the opportunity of beginning his scientific career with the encouragement and under the guidance of his cousin.—(2) The prospective

departure of George Macleay to England, to settle there permanently.—(3) The periodical visits of Surgeon Rayner, R.N., of H.M.S. *Herald* during 1854-61, but especially from 1857-58 and later.—(4) The Rev. R. L. King's friendship with William Sharp and William Macleay, and his growing interest in entomology.—(5) William Macleay's friendship with A. W. Scott of Ash Island, which began with their association as Members of the First Legislative Assembly of 1856.

The most important of these was William Macleay's permanent residence in Sydney, and the opportunity of beginning work while William Sharp Macleay was able to help him.

George Macleay, in 1858, decided to return to England, to settle there permanently. If he had remained in Australia and taken an interest in natural history, the interesting question arises, whether William Macleay would have taken up entomology, or whether he would have turned his attention to some other branch of natural history. Perhaps he might even have turned his back on Science, and taken up something else.

The prospective removal of George Macleay to England, William Macleay's re-awakened interest in natural history, and his own declining health would lead William Sharp Macleay to consider the question of the future disposal of the joint Macleay Collections. And if so, to realize that if they were still further to be developed and made use of, the only hope of keeping up the family reputation and interest in Science was for William Macleay to join the succession.

After George Macleay's departure for England in 1859 to live there permanently, the brothers did not meet again. As William Macleay thus became William Sharp Macleay's nearest male relative and his oldest friend in Australia, it was natural that his cousin should be ready to encourage him by his advice and help, and by making his collections and library accessible to him, as frequent references in William Macleay's papers in the *Transactions of the Entomological Society of New South Wales* show that he did.

The eventual transference of the Macleay Collections to the University of Sydney, by bequest or by gift during the life-time of the owner, seems to have been a matter of mutual understanding between the cousins. William Sharp Macleay, as a Trustee of the Australian Museum at the time, would know that, in or about the year 1852, when the University was inaugurated, the Senate was desirous of having a Museum of its own, perhaps in anticipation of having a Medical School, and even went so far as to take preliminary steps to try and get one, as thus narrated in Etheridge's History—"An extraordinary request was received from the Secretary to the University of Sydney, by direction of the Vice-Provost, asking for a conference between Committees of the Senate and Museum respectively with 'a view of ascertaining upon what terms the Museum and grounds might be transferred to the University', and of course to ascertain primarily whether any proposition would be entertained by the Committee of the Museum". The Committee's reply was brief and to the purpose: "It was unanimously resolved that its acceptance would be detrimental to the interests of the Museum, whilst, moreover, it is one which the Committee, under its present constitution, is not competent to entertain" (Etheridge, Part ii, p. 366).

Another incentive was that as early as 1858, the Rev. R. L. King (1823-97), second son of Rear-Admiral King, was actively interested in collecting and studying insects. This is shown by his sketch of a Pselaphid beetle, dated "Parramatta, April 4th, 1858, R.L.K.", among the relics of William Sharp Macleay,

already mentioned. The sketch is drawn on the back of Mrs. Bobart's visiting-card. This recalls the fact that the Rev. H. H. Bobart, Incumbent of St. John's, Parramatta, and Head Master of the King's School, died suddenly in July, 1854, and that Mr. King succeeded him as Incumbent. Mr. King was a Trustee of the Australian Museum from 1848-57, and a friend, visitor to, and correspondent of William Sharp Macleay. He was also a friend of William Macleay, and they exchanged specimens. Mr. King mentions, in one of his papers, that, to the kindness of William Macleay his cabinet was indebted for many of its choicest Coleoptera. On the foundation of the Entomological Society of New South Wales in 1862, Mr. King became one of its most active supporters, was the second President, and the author of a number of papers. He was appointed to take charge of Moore College at Liverpool in 1868. But his duties and responsibilities in connection with the College prevented the continuance of his entomological work after 1869. Mr. Chris. King, son of the Rev. R. L. King, has kindly shown me a letter from William Macleay to his father, dated August 23rd, 1860, in which he says—"My cousin, W. S. Macleay, pronounced your 'Dopsa' an 'Helephorus' the moment he saw it; and on looking among the Helephoridae of Lacordaire this morning, I find your insect belongs most undoubtedly to the genus 'Ochthebius'. The species, of course, is quite new. I will, if you like, describe it." This letter is of interest for two reasons: It shows that William Macleay consulted William Sharp Macleay on moot points; and also that he was ready to describe insects as early as 1860, nearly two years before the establishment of the Entomological Society of New South Wales, when the Philosophical Society of New South Wales had not the resources to enable it to publish a scientific journal.

Another fruitful incentive to collect on his own account about this time was the periodical visits of Dr. Frederick Rayner, Surgeon of H.M.S. *Herald*, in command of Captain Denham, especially between 1857 and 1861. At a meeting of the Entomological Society of New South Wales on March 2nd, 1863, William Macleay described a new species of *Calloodes*, of which he says—"I have named this beautiful insect after my friend Dr. Rayner, R.N., who has been my companion in many delightful entomological excursions" (*Trans.*, Vol. i, p. xx). Also in another paper, read August 7th, 1865, published in the same volume (p. 221) he says of *Talaurinus Rayneri*, n. sp.—"I received this insect years ago from Dr. Rayner, R.N., who had taken it, I believe, somewhere on the West Coast." Here then is his own testimony to the fact that he went on collecting excursions with Dr. Rayner; and that the latter gave him a specimen which he described, probably one of many from distant localities visited by the donor.

H.M.S. *Herald*, in command of Captain Denham, arrived in Sydney, from England on February 18th, 1853. John MacGillivray, formerly of H.M.S. *Rattlesnake*, was the naturalist. At that time H.M.S. *Torch*, away on a cruise, was expected back. After her arrival, most of her officers and men were transferred to the *Herald*, and the *Torch* remained in Port Jackson. The *Herald* left, on her first cruise, to Lord Howe Island, Isle of Pines, and the New Hebrides, on September 2nd, 1853, and returned to Sydney on January 1st, 1854. Dr. J. Denis Macdonald, Assistant Surgeon, was one of the officers transferred from the *Torch*. But whether Dr. Rayner was also, or whether he came out from England in the *Herald*, I have not been able to ascertain. In a letter written

by MacGillivray to Sir W. J. Hooker after the return to Sydney from the first cruise, in January, 1854, he says, speaking of the visit to Lord Howe Island—"Our surgeon Mr. Reyner [Rayner], who is and has long been a zealous collector for Haslar Museum, volunteered to join my party, and of course Milne was with us" (*Lond. Journ. Bot.*, Vol. v, p. 279). While the *Herald* was in port in January, 1854, Dr. Stimpson paid a visit to the men of science on board on January 5th. The visit was returned on the following day, as narrated in Stimpson's journal.

The *Herald* visited Fiji in 1856, and returned to Sydney in 1857. During this visit Lieutenant Arthur Onslow, grandson of Alexander Macleay, came to Australia for the second time, for service on the *Herald*. In March, 1857, he joined H.M.S. *Iris* to take passage for the *Herald*, Captain Denham, surveying vessel on the Australian station. He was thus employed surveying Shark's Bay, and the numerous detached coral reefs on the East Australian coast outside the Great Barrier Reefs, and in Torres Straits. He returned to England in 1861, in the *Herald*, on the completion of her term of service. So also did Surgeon Rayner, for Mr. A. White exhibited a portion of Dr. Rayner's entomological collections at a Meeting of the Entomological Society of London on November 4th, 1861.

The *Herald* visited Sydney again in July, 1858. Dr. Rayner was present at the Meeting of the Philosophical Society of New South Wales on July 14th, when the second part of Dr. Roberts' paper was read. I have not been able to ascertain the dates of the subsequent visits of the *Herald* before she returned to England in 1861.

But from what has been said it is evident that the presence of Lieutenant Arthur Onslow on board the *Herald* afforded an additional interest to William Sharp and William Macleay in the cruises of the *Herald*; and that William Macleay's delightful entomological excursions with Dr. Rayner may have covered the period 1854-61.

William Macleay's excursions with Dr. Rayner would probably be chiefly in the vicinity of Sydney, possibly also to Brownlow Hill and Camden, Illawarra.

Once only did William Macleay find occasion to mention his experiences in collecting about Sydney in the first stage of his career. At the Meeting of the Entomological Society of New South Wales on February 2nd, 1863, it is recorded that "the President offered, for distribution among the Members, specimens of a *Bembidium* . . . . which had been frequently found by him, and always in the same locality, in Middle Harbour. He had first seen the insect on the 10th October, 1861".

The earliest published record of William Macleay's interest in science before he began to specialize in entomology is his election to Membership of the Philosophical Society of New South Wales, at the Fourth Monthly Meeting held on 13th August, 1856, about a year before his marriage and residence in Sydney. This shows an awakening interest in natural history before he came to live in Sydney and before he began to specialize in entomology.

At the Fourteenth Monthly Meeting on 14th October, 1857, Dr. Alfred Roberts read Part i of a Paper "On the Poison-apparatus of Venomous Snakes", which was published in the *Sydney Magazine of Science and Art* (Vol. i, 1858, p. 130) under the title "On the Structure and Functions of the Venom Apparatus in Serpents". The author says—"The present mode of classification (of the Order Ophidia) is well exemplified in the following table, for which I am indebted

to the kindness of Mr. Wm. Macleay, who abridged it for me from the valuable work of Dumeril and Bibron. In his opinion, it is far the best, as it is the most simple, that has been hitherto published." The second part of the paper was read at the Nineteenth Monthly Meeting on July 14th, 1858, under an amplified title "On the Structure and Function of the Poison Apparatus in Venomous Serpents with a Description of some of the Species found in Australia". The paper was illustrated by numerous specimens, both living and preserved, and by drawings. The author says—"All the land snakes of this colony are described from fresh specimens, the water snakes from specimens in spirits, with which I have been kindly favoured by W. Macleay, Esq., Dr. Rayner, J. D. Macdonald Esqr., and the Rev. W. W. Campbell." In Maiden's "Contribution to a History of the Royal Society of New South Wales" (*Journ. Proc. Roy. Soc. N.S. Wales*, Vol. lii, 1918, p. 272) it is stated that the paper was illustrated by drawings by Dr. MacDonald of H.M.S. *Herald*. When the second part of the paper was read, Dr. Rayner was present, and exhibited some living specimens of marsupials in cages which he had brought from Western Australia.

In the absence of the President, Sir John Young, successor to Sir William Denison, from the Fifty-seventh Meeting on May 27th, 1863, William Macleay was voted to the Chair. He laid on the table a copy of Vol. i of the *Transactions of the Entomological Society of New South Wales*. At this Meeting also Mr. Krefft read a paper "On the Reptiles found near Sydney".

Having made a good start, another incentive to continue was his election to the Board of Trustees of the Australian Museum on 7th March, 1867, *vice* Sir William Denison, who left Australia to take up Vice-Regal duties in India. This official association with the governing body of the Australian Museum would be likely to stimulate his interest in natural history generally.

Before July 23rd, 1861, he had acquired an important collection made for him at King George's Sound, by Mr. Damel. On the date mentioned, he had living specimens of the larvae of *Charagia scripta* undergoing their metamorphoses in the roots of a *Leptospermum*, as mentioned in William Sharp Macleay's letter to Miss Scott. Damel, therefore, made the collection during the season, 1860-61. The resulting collection was the first large, as far as possible, exhaustive collection made in a definite area outside New South Wales, which came into William Macleay's possession.

He had also received a large number of insects from the Rockhampton district, collected by Mr. W. S. Wall (1814-76), who retired from the Curatorship of the Australian Museum on account of ill-health on December 31st, 1858. Shortly afterwards Wall visited Queensland for a change and spent some time in collecting in the neighbourhood of Rockhampton. Some of the material obtained was disposed of to the Australian Museum and some to William Macleay and possibly to others. Among the relics of William Macleay is an order for the payment of a sum of money to a representative in Sydney dated from Rockhampton, January 13th, 1860, and signed by W. S. Wall. On the back of this in William Macleay's writing is a list of eight sums of money (including the amount on the order mentioned). These evidently correspond to a list, on a loose sheet, of eight boxes of "insects from Rockhampton" also in William Macleay's writing, of which the last two were received in January and March (1860), with the numbers of the insects in each box, the total being 4,610.

Up till the year 1860, William Macleay's collection was the result of his own efforts, chiefly in the neighbourhood of Sydney, or in localities a little more remote, together with exchanges or gifts from his friends. But in the year mentioned, he began to supplement his own efforts, by sending expert collectors to distant localities. Of the first two collections made in this way, in 1860-61, and 1861-62, one had been in his possession for about a year and the last instalment of the second was expected when the inaugural Meeting of the Entomological Society of New South Wales was held. Other collections were obtained from temporary or permanent collectors living in distant localities. Alexander and William Sharp Macleay had had little or no opportunity of getting such complete collections from definite areas as some of these. It was the acquisition of large collections of this sort, supplemented by his own efforts and the co-operation of friends, that enabled him to say in 1873 that his Australian entomological collection was the best that he knew of.

The only original letter written by William Sharp Macleay that I have seen, is one to Miss Harriet Scott of Ash Island, dated 23rd July, 1861. It is a long letter in reply to an inquiry of Miss Scott about the nomenclature of the species of *Charagia*, whose larvae are lignivorous.

But in the course of his remarks the writer says—"You have got a new and fifth species under the name of *C. Ramsayi*; and my cousin has given me the ♀ of another quite new and sixth species from King George's Sound under the name of *Charagia scripta* Macleay Junr. MSS. It has the silver spots like letters, and small, instead of being large and round, as in *C. Ramsayi*. My cousin will, I am sure, be happy to show you ♂ ♀ larva and chrysalis, of this K.G. Sound species. He has the larvae now alive in the roots of a Leptospermum." Mr. Scott, about six years later, described the species in his paper "On the Genus *Charagia* of Walker", in *Trans. Ent. Soc. N.S. Wales*, Vol. ii, p. 34, and adds—"Several chrysalids in the wood were brought from King George's Sound, Western Australia, in 1861, for W. Macleay Esq., of Elizabeth Bay; and in whose collection the perfect insects are; from these specimens the foregoing description has been taken." The paper was read on 2nd September, 1867.

The specimens were collected by Mr. Damel, and formed part of a collection which is referred to three times by William Macleay (in *Trans. Ent. Soc. N.S. Wales*). Of *Macrothops rostrata*, n. sp., he says—"I received three specimens of this very remarkable insect from King George's Sound, and it was the only Glaphyrideous species I got from that settlement, out of a very large collection" (Vol. i, p. 90). Of *Talaurinus damelii*, n. sp., he says—"I name this species after Mr. Damel, who made a fine collection of the insects of King George's Sound for me a few years ago" (in 1860-61, as we learn from Mr. Scott's paper: Vol. i, p. 242. The paper was read 7th August, 1865). Also of *Platylytron amplipenne*, n. sp., he says—"I received several specimens of this insect from King George's Sound some years ago" (Vol. ii, p. 328).

This collection was the first important collection of Australian insects acquired by Sir William, of which there is a definite record.

At the third meeting of the Entomological Society of New South Wales, on July 7th, 1862, William Macleay introduced Mr. Damel to the Members as having just returned from the Feejees, after a year spent in the collection of objects of Natural History in these Islands. But whether all or any of this

collection was acquired by him or, if otherwise, what became of it, is not known to me.

At the same Meeting William Macleay "exhibited a number of new species belonging to the families Cicindelidae, Carabidae, Anoplognathidae, and Cetoniidae", together with some new or previously unrecorded Lepidoptera, which he had just received among a large collection of insects from Port Denison, obtained for him by Mr. Masters, whom he introduced to the Members. The accumulation of this fine collection was the beginning of George Masters' collaboration with William Macleay in carrying out his zoological enterprises, eventually of so much importance; and came about in a very simple way.

George Masters (1837-1912) emigrated from England to Melbourne about 1856 or 1857. He was an expert gardener, who, in his leisure, had become interested in Natural History. For two years he was employed by Dr. Godfrey Howitt, then practising medicine in Collins Street, an enthusiastic entomologist and owner of a collection, which he eventually bequeathed to the University of Melbourne. Masters then visited Tasmania for a time, and made a collection of insects, which subsequently William Macleay purchased. He next came to Sydney in about 1859, and obtained employment at Shepherd's Darling Nursery. He utilized his leisure, as far as possible, in collecting insects, or in visiting the Australian Museum to see the entomological collection in the hope of ascertaining the names of his specimens. Finding that some of those on view were, as he thought, incorrectly named, he made himself known to the Curator, Mr. G. Krefft, and pointed out certain mistakes, and was thanked for his trouble. At this time, of course, the Curator, who was not an entomologist, was the only scientific member of the very limited staff. About this time, William Macleay asked Mr. Krefft if he could recommend someone who could undertake collecting for him. Mr. Krefft replied that a young man, who frequently came to the Museum in search of names for his specimens, would perhaps be suitable; and offered to arrange for an interview. The interview was satisfactory, and Masters was despatched to Port Denison. An attack of malaria somewhat hastened his return, but William Macleay was well pleased with the results. This was the second special addition to his collection, and some of it inspired the first of his papers contributed to the Entomological Society of New South Wales.

At the beginning of the year 1862, William Macleay was not only ready to begin descriptive work, but had determined to arrange for its publication, even if this involved financial responsibility.

Contributory factors to this advance were, that he had now had about four years' experience of systematic collecting in the vicinity of Sydney, and to some extent outside the County of Cumberland; and that the resumption of his friendly intercourse with William Sharp Macleay afforded opportunities for a comparative study of his own steadily growing collection and of William Sharp Macleay's collection, to which he now had access, as well as of discussing his experiences and his acquisitions with his cousin. Evidence of this is furnished both by William Sharp Macleay's letter to Miss Scott (Part i of this Address, PROCEEDINGS, 1920, p. 625), and by his remarks on, or exhibits of, specimens in William Sharp Macleay's cabinet or collected by the latter, at early Meetings of the Entomological Society of New South Wales, during William Sharp Macleay's life-time.

As a matter of fact, William Macleay was ready to make a start in 1860, as indicated in a letter from him to the Rev. R. L. King, for which I am indebted to Mr. Chris. King, son of the recipient of the letter. This letter is the only one from William Macleay to any of his scientific correspondents, that, to my knowledge, has been preserved. It is, therefore, of special interest. . . .

"Sydney, 23rd August, 1860.

"My dear King.

"My cousin, W. S. Macleay, pronounced your 'Dopsa' an 'Helephorus' the moment he saw it; and on looking among the Helephoridae of Lacordaire this morning, I find that your insect belongs most undeniably to the genus 'Ochthebius'. The species, of course, is quite new. I will, if you like, describe it, and call it Kingii.

"I never saw the genus 'Dopsa', but the next genus, 'Eumolphris', I have seen, and it has no resemblance to 'Helephorus'. Dopsa is trimerous, I fancy. The Helephoridae are pentamerous, though the first joint is sometimes so short as to make them appear tetramerous.

"I should like to know something more of the habitat, and mode of catching the insect.

Yours sincerely, William Macleay."

From this letter it appears that the Rev. R. L. King had sent William Macleay a specimen new to him, with a request for identification; and that, not recognizing it, William Macleay submitted it to his cousin. Unfortunately no letters from the Rev. R. L. King to William Macleay, nor from any other of the latter's early scientific correspondents, have been preserved.

Nothing came of the offer to describe Mr. King's insect. One reason for this may have been that there was then no scientific journal published in Sydney. Another may have been that the Rev. R. L. King was not quite ready to begin descriptive work. The first paper contributed by Mr. King to the Entomological Society of New South Wales, "On the Pselaphidae of Australia", was read on November 3rd, 1862, but some of the specimens—a group in which he had for some time been interested, as indicated by the sketch of a Pselaphid, dated 1858, sent to William Sharp Macleay—had been collected at Parramatta only in July-September of the same year. Before the date of this paper, William Macleay and Mr. King had been exchanging specimens, because, of one of the new species described, the latter says—"I have named it after W. MacLeay Esq., M.L.A., to whose kindness my cabinet is indebted for many of its choicest Coleoptera" (**Trans.*, Vol. i, p. 41).

The Entomological Society of New South Wales was initiated at a preliminary Meeting held on April 7th, 1862. The circumstances which culminated in this enterprise have an inner meaning, which is not hard to find.

The progress of our knowledge of the Australian fauna presents two stages. The first is represented by the work of European or other non-Australian zoologists upon collections taken to Europe by the early navigators or voyagers, or taken home by residents or visitors in the early days of settlement. The zoologists who described the specimens too often suffered from the disadvantages of having

* This and succeeding similar references are to *Trans. Ent. Soc. N.S.W.*

incomplete collections, which were not representative of the fauna of definite areas, as well as from having no personal knowledge of the animals under natural conditions; they also often had a very vague knowledge of the geography of Australia.

The second stage began when zoologists in Australia, with personal knowledge, commenced to take up the study of the fauna. Their chief drawbacks were, that the collections containing named or type-specimens were too far away to be consulted; that, at first, scientific libraries here were very inadequate for their needs; and that there was so little opportunity for cultivating a taste for zoology, except as a hobby, in one's leisure.

When the Entomological Society of New South Wales was instituted, the Museums in Sydney, Melbourne, and Adelaide, had no scientific staff except the Curator or Director, whose attention, quite naturally, was claimed chiefly by the Vertebrata, or, in addition, by some of the more conspicuous Invertebrata other than insects.

Early in 1862, William Macleay had evidently arrived at the conclusion that the time was ripe for inaugurating the study of entomology in Australia, and that Sydney was the proper place to make a beginning, because the collections of Alexander and William Sharp Macleay were here, and these contained many named specimens, some of them type-specimens. William Sharp Macleay's scientific library was also in Sydney, and William Sharp Macleay himself was here; though his working days were over, and his health was manifestly on the decline, his advice and guidance were still available. William Macleay had been accumulating a collection for about four years, and was ready to begin descriptive work, but did not wish to go alone. The Philsopohical Society of New South Wales had not the resources to enable it to publish a journal. Even if it had been able to do so, the journal would hardly have been a suitable medium for the publication of technical entomological work. William Macleay knew what residents of Sydney were interested in zoology, and especially in entomology, and, as the first step in organizing local effort, he arranged for holding the preliminary Meeting on April 7th, 1862.

Up till 1918, the fate of the Minute Book of the Entomological Society of New South Wales was unknown, and it was supposed to have perished in the fire which destroyed our Society's early official records, in 1882. It was unexpectedly unearthed in the strong-room of the Australian Museum, and was thoughtfully restored to us by the Curator, on behalf of the Trustees. When the Entomological Society ceased to hold formal Meetings, after that of February, 1869, Mr. Krefft was Honorary Secretary; he retained the Minute Book, and its existence or its whereabouts was forgotten.

The Minute Book contains some important supplementary information about the Meetings, which is not given in the printed *Transactions*. The Inaugural Meeting on April 7th, 1862, was held at William Macleay's residence, 153 Macquarie Street. Eight gentlemen were present—William Macleay, Dr. Alfred Roberts, H. F. Schrader, G. Krefft, E. P. Ramsay, W. J. Stephens, J. B. Turner and Dr. J. C. Cox, the record being in the handwriting of Dr. Cox, and the order of the names as given. The first resolution carried was that Mr. Macleay take the chair. The second, that the Society be established. The third, that Mr. William Sharp Macleay be appointed Honorary President. He, however, subsequently declined official responsibilities on account of his failing health, but was ready

to become a member. William Macleay was accordingly elected President. The record of this first Meeting ends with the unpublished statement that—"A vote of thanks was unanimously given to Mr. William McLeay for his duties as Chairman, and for having been the originator of the Society". From this it is evident that William Macleay was behind the enterprise and was the moving spirit. The Rev. R. L. King and Mr. A. W. Scott, on whose co-operation he was relying, were unavoidably absent, as they lived out of Sydney, but he was relying upon their assistance, which was forthcoming at a later stage when wanted.

Before summarizing the work accomplished by the Entomological Society of New South Wales, William Macleay's efforts to enlarge his collection during the period commencing with the establishment of the Society in April, 1862, and ending with the year 1873, may first receive consideration. Before this period, the insect-fauna of the vicinity of Sydney (County of Cumberland), although it was the earliest Australian settlement, was very imperfectly known. The early European entomologists had studied miscellaneous collections, usually comprising specimens from many distant localities; and the habitats recorded were often vague. Consequently there was a lack of papers dealing exhaustively with the fauna of definite areas.

The establishment of the Entomological Society of New South Wales was important, because it brought together not only those interested in entomology who resided in Sydney or within reach of it, but others interested in natural history, who were glad of an opportunity of learning more about one little-known branch of the fauna. It concentrated attention on a class which previously had received little more than unrelated, individualistic consideration. It greatly stimulated collecting, provided opportunities for the exhibition of collections and of discussions thereon, and prepared the way for exchanging specimens.

Moreover, after his return from Port Denison in July, 1862, and the completion of his engagement in regard thereto, George Masters decided to become a practical entomologist, and to devote his time to general collecting, probably with the encouragement of William Macleay. This he did assiduously, up to the time of his appointment to the Australian Museum in June, 1864. He also joined the Entomological Society of New South Wales, and from January, 1863, onwards, regularly exhibited rare or remarkable specimens, or fine collections. His exhibits greatly contributed to the interest of the Meetings. In his second Presidential Address (on March 7th, 1864) William Macleay said—"I cannot permit this opportunity to pass without expressing the obligations which the members generally are under to Mr. Masters, for the exhibitions, at each monthly meeting, of his rare and beautiful collections."

As William Macleay's collection began to improve by the additions of gifts from or exchanges with his fellow-members, and by his acquisitions from Masters, as opportunity offered, he began to go further afield to collect.

The localities in which William Macleay collected, as mentioned in one or other of his papers, include: Camden and Brownlow Hill, Illawarra (Wollongong, Mt. Kembla), Lower Murrumbidgee (Kerarbury, near Burrabogie, Wagga, Lake Albert), Upper Murrumbidgee (Yass), Mundarlo and Tarcutta, Wingelo, Shelley's Flat, Queanbeyan and Monaro districts, Murrurundi, Bathurst and Currajong.

There are fuller particulars of his collecting excursions to localities still more remote from Sydney. At this time, it is to be remembered that the first railway to Parramatta, 15 miles, had been opened in September, 1855; but that the

southern extension to Goulburn, 140 miles, and the western extension to Mt. Victoria, 79 miles, were not opened until May, 1868, and May, 1869, respectively; and to Wagga, 309 miles, in September, 1878.

William Macleay made two visits to Kerarbury, the station in which he was interested, on the Lower Murrumbidgee, between Narrandera and Hay, in August, 1864, and in the spring of 1872. His records of these visits are given in *Trans. Ent. Soc. N. S. Wales*, Vol. i, p. xxxix; Vol. ii, p. 338. The first is the notice that at the meeting on September 5th, 1864, "Mr. MacLeay exhibited forty-six species of Carabidae, taken by himself during the previous month, on the Lower Murrumbidgee". From the then railway-terminus, these journeys were made in his own wagonette or in hired vehicles, travelling by day, and putting-up for the night at the road-side inns. In this way, opportunities were afforded of collecting at intermediate places, as, for example, at Wingelo, Shelley's Flat, near Goulburn, Yass on the Upper Murrumbidgee; and, on the Lower Murrumbidgee, at Lake Albert and Burrabogie near Wagga, Mundarlo, Tarcutta, and finally at Kerarbury. Insects from all these localities were described in his various papers.

Other excursions were to the Queanbeyan and Monaro districts in January, 1870; Murrurundi, with George Masters, in the summer of 1872; Bathurst, Piper's Flats and Blue Mountains, also in the summer of 1872.

Of the first of these, he says: "In the month of January, 1870, I made a hurried entomological excursion into the Queanbeyan and Monaro districts. I was accompanied by Mr. Masters, of the Australian Museum, by whose assistance, notwithstanding the intense heat and dryness of the season, I was enabled to add a number of new and interesting species to my own as well as to the public collection" (*Trans.*, Vol. ii, p. 319).

Collecting was carried out at the Umeralla River, the Queanbeyan River, and on the Downs beyond Cooma, and in the vicinity of Spring Flat. Among the captures then made, there were "two species of small Carabideous insects which peculiarly interested me. One of these has since been described by H. W. Bates, Esq., in the 'Entomologists' Monthly Magazine' for July, 1871, under the name of *Eudalia Macleayi*."

This remark is of interest because it shows that soon after his return from Monaro, William Macleay was corresponding with Bates in England, and sending specimens to him.

A still earlier English correspondent with William Macleay was F. P. Pascoe. In a paper read at a Meeting of the Entomological Society of London, on July 6th, 1863, Pascoe acknowledges the receipt of an extensive collection of Australian Longicornia, including specimens of thirty species new to him, "that I recently received from Wm. Macleay Esq., M.L.A." (*Trans. Ent. Soc.*, (3), Vol. i, p. 526). Unfortunately no letters either from Pascoe or Bates were preserved.

As soon as the Entomological Society of New South Wales began to publish its *Transactions*, the interest of entomologists in some of the other Colonies was aroused. Some of them joined the Society, and the local members, particularly William Macleay and the Rev. R. L. King, began to correspond and exchange with them, and in some cases to describe their specimens. These included Dr. Godfrey Howitt (ob. 1873) of Melbourne, and Mr. H. Edwards of Ballarat; Messrs. F. G. Waterhouse, G. F. Angas, and J. Odewahn and Mrs. Kreusler of South Australia; and Mr. S. Diggles of Brisbane.

Before January 5th, 1863, William Macleay was in correspondence with Dr. Howitt, and had received a collection from Melbourne, as mentioned in the first

of his four papers on the Scaritidae, read on the date mentioned. In his paper on the Amycteridae, read on August 7th, 1865, acknowledgments of the receipt of a number of the insects described, from Dr. Howitt, are recorded. William Macleay says of the type of *Psalidura subvittata* (p. 212): "Dr. Howitt captured one specimen of this insect near Ipswich a few weeks ago." This statement may be taken to imply that perhaps on the way to Queensland, as well as on the return journey, Dr. Howitt called at Sydney, made the acquaintance of William Macleay, saw the Macleay Collections, and exchanged specimens.

At the fourth meeting of the Entomological Society of New South Wales, on August 4th, 1862, "Dr. Cox stated that he had received a letter from Mr. (Henry) Edwards of Ballaarat, expressing his wish to enter into a system of exchange with any of the members of the Society." William Macleay possibly did respond to this invitation, but there is no record of it in the *Transactions*. Subsequently Mr. Edwards returned to the United States and, as narrated later, for some years after 1874 regularly exchanged with William Macleay. The Rev. R. L. King exchanged with Dr. Howitt and Mr. Edwards, and described species from their collections, as mentioned in his second paper on Pselaphidae (*Trans.*, Vol. i, p. 167). In this paper also, Mr. King described specimens sent by Count de Castelnau, who came to Melbourne in 1863. At a later date, Count de Castelnau corresponded with William Macleay, and visited him in Sydney, and exchanged, as mentioned further on. But there is no record of their correspondence in the publications of the Entomological Society of New South Wales.

In his second paper on the Scaritidae, read on March 7th, 1864, William Macleay described a number of new species from a collection sent by Mr. F. G. Waterhouse of South Australia to Mr. E. P. Ramsay. This led to exchanges with Mr. Waterhouse, as mentioned in William Macleay's third paper on the Scaritidae, read on March 6th, 1865. Of the type-specimen of one of the species described, William Macleay says: "It is one of the many rare things, for which I am indebted to F. G. Waterhouse, Esq., of the South Australian Institute", afterwards the South Australian Museum. As mentioned later, important exchanges other than of insects, were carried out regularly for some years.

George French Angas, Secretary of the Australian Museum from July, 1853 till February, 1860, subsequently removed to South Australia. In his paper on the Amycteridae, read August 7th, 1865, William Macleay says of two of the type-specimens described in the paper, "I have named the species after G. French Angas, Esq., from whom I received this among many other of the insects of South Australia", and "This insect was sent to me from Adelaide some years ago by G. F. Angas, Esqr." (*Trans.*, Vol. i, pp. 258, 286).

Mr. Johannes Odewahn, of Gawler Town, S.A., sent specimens of Scaritidae to William Macleay. Three references to these are given in William Macleay's fourth paper on the Scaritidae, read on September 6th, 1869, one of which is, "I am indebted to Mr. Odewahn for this (the type-specimen of *Carenum nitescens*) as well as many other of the South Australian species of Scaritidae" (*Trans.*, ii, pp. 65, 68, 70); the other two are in his last paper, "Miscellanea Entomologica", read July 7th, 1873 (*Trans.* ii, pp. 325, 348).

Mrs. Kreusler, also of Gawler Town, exchanged with Mr. Odewahn, and also with the Rev. R. L. King, who described specimens from her collection.

Mr. Silvester Diggles, of Brisbane, also sent or loaned specimens to William Macleay. There are three references to these in William Macleay's fourth paper on the Scaritidae (*Trans.*, ii, p. 61), and one in the "Miscellanea Entomologica"

(ii, p. 326). The second of these is, "The only specimen I have seen was sent from Brisbane by Mr. Diggles, with a number of Coleoptera, many of which were not Queensland insects" (p. 67).

An important addition to William Macleay's collection, about 1866, was one made at Port Denison and Cape York by Damel. All the available particulars about it are the following: At the meeting on June 4th, 1866, "Mr. Macleay exhibited four Lepidopterous insects which he had taken out of a collection sent to him by Mr. Damel from Port Denison. He said that he had selected them, as they were insects rarely met with in collections, and would most probably be new to the Members present" (*Trans.*, i, p. lviii). At the same meeting a new species of *Tetracha* from the same collection was described. Five species were described from Cape York in his fourth paper on the Scaritidae (p. 69), and in the "Miscellanea Entomologica" (pp. 323, 335), respecting one of which it is stated, "Among a number of new and very interesting Coleoptera brought by Mr. Damel from Cape York some years ago, was an unique specimen of a very remarkable and gigantic Carabideous insect" (p. 335).

Third and Closing Period, 1874-91.

The transition from working zoologist intent on improving his museum, to promoter and benefactor of Natural Science in New South Wales: "our most munificent patron of science and chief benefactor of higher education" (W. B. Dalley, 1887).—The keynote to this period is the reason for his resignation from Parliament, as given to his constituents—"I intend to give my attention henceforth entirely to Natural History, and the improvement of my museum" and, had he known what was awaiting him as the result of the establishment of a Natural History Society he might have added, to help to put the Linnean Society of New South Wales on its feet, as the first step to its becoming a going and lasting concern.

Information Chiefly Obtained from William Macleay's Journal During the Years 1874-1882.

1874.

Five important events: (i) William Macleay appointed George Masters Curator of his museum on Feby. 6; their joint efforts, with the assistance of J. Brazier and E. Spalding for part of the year, to improve the museum—(ii) March 28th. The public announcement by the Chancellor of the University of the Senate's acceptance of William Macleay's offer to bequeath the Macleay Collections and his library—(iii) April 6th-June 8th. Visit of H.M.S. *Challenger* on a circumnavigating voyage, with a scientific staff under the leadership of Professor Wyville Thomson; its stimulating effect on the zoologists of Sydney—(iv) September-October. The unexpected proposal to establish a Natural History Society, and what came of it—(v) November 28th. Parliament dissolved; William Macleay's retirement in order to devote his time to the study of natural history and the improvement of his museum.

(i). Appointment of G. Masters as Curator.

In William Macleay's letter to the Senate, written towards the end of 1873, he said: "The Zoological collection which I leave to the University comprises very few specimens of the vertebrate animals, and except so far as Australian species

are concerned, it is not likely that I will attempt to add to it." This statement implies that he intended to improve the collection by the addition of Australian vertebrates, and possibly others. Having committed himself to this definite offer, he began to realize that he would need the help of a permanent assistant. He decided, therefore, to appoint a Curator of the collections; and to advertise for applications for the position. In the meantime, William Macleay happened to see G. Masters, who expressed himself as very much dissatisfied with the conditions at the Museum and talked of resigning. William Macleay notes this in his Journal of January 20th, 1874, and adds—"If he does, I shall at once engage him for my collection." At this time the relations between the Curator and his assistants were becoming very strained, as they became soon after with the Trustees.

On January 23rd William Macleay noted in his Journal that Masters had sent in his resignation as Assistant Curator of the Australian Museum. Also that —"I feel myself at liberty now to offer him £300 a year to assist me (when he is free) with my collection, with a promise of his having the curatorship of the Macleayan University Museum on my death, at the same salary. I shall take every opportunity of enlarging the Collection in all branches of Natural History, but I shall chiefly strive for excellence as a Museum of 'Animalia invertebrata' ". Masters accepted the offer, and entered upon his new duties on February 6th. The Journal adds that, after settling preliminaries "Our chief work to-day was getting books in order for the binder."

The appointment of G. Masters as Curator of the Macleay Collections was of the greatest importance, as the preliminary step towards their improvement. Henceforth, as long as it was necessary, William Macleay devoted the mornings, and, when he could, the afternoons, to co-operative work with his Curator. Both were keenly interested in the work ahead of them and they worked together most harmoniously. Their first year's co-operative or individualistic efforts, with the assistance of J. Brazier and E. Spalding for part of the year, and supplemented by the spontaneous help of friends, may be considered under the following heads: (1) Routine work—(2) Marine collecting: (*a*) Shore-collecting in Port Jackson, and at Bondi after gales; (*b*) four weeks' systematic dredging in Port Jackson, and between and outside the Heads; (*c*) the ketch *Peahen* was chartered for two months to enable J. Brazier and an assistant to collect and dredge at Jervis Bay and Port Stephens; (*d*) five "Fishing Picnics"—(3) Land-collecting: (*a*) between Bondi and Botany Bay; (*b*) in the old garden, then intact; (*c*) two country excursions, one to Wagga, the other to Gunning; (*d*) E. Spalding engaged for six months to collect at Port Denison—(4) Exchanges—(5) Donations—(6) Purchases.

(1) *Routine work.*—(*a*) The scientific library, comprising about 2,000 volumes, first received attention. Unbound volumes and Journals issued in parts, were collected and sent to the bookbinder. Orders for additional books, including ten missing volumes of the *Transactions of the Linnean Society of London*, a complete set of the *Proceedings and Transactions of the Zoological Society*, the scientific portion of the "Voyage of the *Novara*", and other important books were sent to a bookseller in London. (*b*) New cabinets were ordered; supplies of glass jars, bottles and tubes were obtained in Sydney, or ordered in quantity from England; spirit, tanks for large specimens in spirit, corks, pins (6 lbs.), glass-topped boxes, and other accessories were provided. Equipment for marine collecting "when the weather becomes cooler" was got together. (*c*) Much time was spent in naming and putting newly acquired specimens into the cabinets, in re-arranging the contents of drawers and cabinets, in putting away duplicates, and in overhauling

and fumigating the contents of the 320 drawers containing William Macleay's collection, as some of them showed traces of *Anthrenus*. The Diurnal Lepidoptera, with the exception of the Hesperidae, in the old collection were taken out in instalments of about 100 at a time, relaxed, re-set, and put away again. This work, for part of each day as far as possible, was begun on February 7th and completed an April 2nd.—(*d*) On April 17th the task of amalgamating the Macleay Collections was taken in hand. The record is—"Masters and I sorted our collection of yesterday (marine forms obtained at Shark Island) in the forenoon; and, in the afternoon, moved some specimens of Australian Coleoptera from W. S. Macleay's cabinets to my cabinet of Australian Coleoptera. I have determined now, as the two collections are going the same way, no longer to keep them separate, but to have the one collection only, known as the Macleay Collection. The Australian insects being more complete in my cabinet, I intend to use it for that purpose, while the foreign insects, for a similar reason, I will accumulate in W. S. Macleay's cabinets" (that is, the cabinets of the joint collection of A. and W. S. Macleay).

The amalgamation of the Macleay Collections, begun in April, was continued intermittently throughout the year. The Coleoptera, commencing with the Scaritidae and Buprestidae, first received attention. In September, the Diurnal Lepidoptera were taken in hand; and in November, the Lepidoptera Heterocera. The species represented in the amalgamated Collection were then marked off in British Museum or other Catalogues, and lists of desiderata were prepared. On October 2nd, William Macleay notes in his Journal—"Masters and I were employed all day at the Butterflies, and made a good deal of progress. I was astonished to find the W.S.M. [W. S. Macleay] Collection very deficient in some groups of the Papilionidae, particularly in the South and Central American things." On October 14th, after the Papilionidae (12 drawers) and the Pieridae had been finished with, he notes—"I made a list of all my desiderata among the Papilionidae, a much longer list than I anticipated. I shall send it to some man in London, who can purchase specimens as they turn up; but many I shall never get." An order for some of the desiderata was afterwards sent to Boucard (*postea*).

Other preliminary routine work. Alexander Macleay's Collection seems to have comprised insects almost exclusively. But William Sharp Macleay's Collection, when he brought it out from England, was a collection of Annulosa, including the Classes Insecta, Myriapoda, Arachnida, and Crustacea. Such of the specimens as were small, or in tubes in spirit, doubtless occupied some of the 480 drawers. But, in addition to these, William Sharp Macleay accumulated a considerable miscellaneous collection of specimens, after he came to Australia, which were not in the cabinets; and were not mentioned in William Macleay's letter to the University. One reason may have been that some of them were not labelled; others were, and had been for a long time, in spirit; and, in so far as they were common or easily procurable specimens, could be replaced by better specimens without much trouble. There are three references to these specimens in the Journal. At this time, William Sharp Macleay's collection and William Macleay's collection were kept in separate rooms. On March 2nd, the record begins—"Masters and I laid out about 90 Butterflies (for relaxation and resetting), and, in the afternoon, we made a commencement of looking over and rebottling the snakes, lizards, &c., which have been bottled up in the collection for many years. They are heaped together without any order, and there is no indication of name

or country." "March 20th—In the afternoon, we looked over, sorted, and packed away a heap of shells and corals which had, for long, encumbered this room." On 8th April—"Masters and I employed ourselves all the forenoon in sorting and rebottling all the things lying about in the W. S. Macleay room", no doubt the "Mr. William's room", mentioned in J. D. Hooker's letter to his father (PROC., 1920, p. 589). On 9th April—"Masters and I were employed all day in regulating the mixed heap of minerals, shells, bottled animals, and bones upon the shelves in my room. We rebottled and respirited most of the things. To complete the work will take some days." "April 11th—Masters and I were engaged till 12 o'clock in arranging the bones, fossils &c., on the shelves." "July 22nd—This afternoon while looking out cases for the books (to be sent to England) I came across shells, fossils, &c., in a recess under the stairs." And on the following day—"Masters and I, in the morning, looked over and sorted the shells, fossils, minerals, &c., found in the recess yesterday."

(2) *Marine collecting.*—(*a*) *Shore-collecting in Port Jackson, and at Bondi, etc.*—One of the most important co-operative enterprises of William Macleay and Masters during 1874, was the inauguration of systematic marine collecting, especially in Port Jackson. Considerable progress was made before the year ended by their own efforts, as well as in other ways. The earliest reference to the subject in the Journal is—"March 9th. I ordered to-day, at Lassetter's, a small steel crowbar, chisel, and hammer, so as to be fully equipped for the collection of marine animals when the weather gets cooler." The first attempt was made on March 27th—"Masters and I spent an hour this morning on the beach, and made a considerable collection of marine animals." At this time the old garden had not been cut up and the sea wall had not been erected. On five days (March 30th, April 13th and 16th, and May 12th and 13th) when the tides were suitable, Tom Mulhall, fisherman, came with his boat, and shore-collecting was carried out at Liardet's Beach, between Sirius Cove and Bradley's Head, Clark Island, Shark Island—"where we made a large collection of fine things. Altogether we had a good day"—Clark Island (second visit), Liardet's Beach and Bradley's Head, Bradley's Head to Taylor's Bay. "Altogether a large amount of material was obtained; and progress was made in sorting, bottling, and labelling, as far as possible, the specimens."

Two excursions to the ocean-beaches at Bondi and Long Bay, after a heavy gale, were made on April 28th and 30th, "to see what the sea had thrown up". Two dead Sooty Petrels, a fine *Scorpaena*, and some miscellaneous specimens were brought back on the first occasion; and a number of Crustacea and Mollusca on the second.

On May 4th—"We found fishermen drawing the seine in the (Elizabeth) Bay, and got a few species of fish from them, which we had not got before. Masters found on the beach a species of *Truncatella*, which is very rare; and is improperly looked on as a land-shell". On May 5th—"About 11.30 a.m. Hastie, the fisherman, came with his net, and we had two hauls on the beach, without, however, getting more than one or two species which we had not got before. Of edible fish there were very few—a flounder, two Black-fish, a Tailor, and a couple of garfish were all. In one haul, we got an enormous number of young Trevally. Hastie afterwards, at 6 p.m., brought a few more strange fish as specimens; altogether we added about a dozen to the Collection."

After the date mentioned, Hastie saved fine, rare, or scientifically interesting specimens from his catches, and on seven different occasions brought them to

the House, or left them at the gardener's cottage near the beach. These included examples of "a very handsome fish known to fishermen as 'The Pig' "; a Nannygai; "a species of Whiting new to me"; three Sharks; five fishes (a Rock-fish, two Rainbow-fishes, and two species of Whiting); a Cestracion Shark, a gigantic Snapper, and a Sargeant-Baker, "all of which I intend for specimens"; two John Dorys and a Nannygai. "The gardener brought up several fish caught last night on the beach: I put into the vat a Stingray with two large spines on the tail, another, a small one, with one spine, a large Catfish, and a fine Leather-Jacket." Another fisherman, Lee, besides *Trigonia*, brought "three specimens of a pretty little fish, quite new to him and to me"; and "a species of Shark, about 3 feet long, and full of eggs, of a species I had not got before"; a few choice fish.

As an example of the way in which specimens from the above sources, or from Mr. Dalley, came under William Macleay's notice, the following extract from the Journal for November 24th is worth quoting: "When Onslow and I got home here very late (after a prolonged adjourned debate in the Legislative Assembly) I found two very handsome fishes on a plate in the Hall, which I at once placed in the spirit-vat."

(*b*) *Dredging in Port Jackson.*—In June and July, dredging was systematically carried out. The first record is—"June 17th. Masters and I went out in Halstead's steam-yacht, accompanied by Mulhall with his dredge. We met with Dalley and Vaughan fishing at Vaucluse. There was a heavy sea on, so that we did not cross the Heads. We had a fine haul of Trigonias at the Sow and Pigs, about 35 in one haul. Masters shot three Terns and two Gannets. We also got a few Crustaceans and shells. I was so pleased with the steamer for speed, comfort, and conveniences for dredging, that I have hired her for four weeks, at £10 per week. In that time, if the weather is favourable, I ought to get a great many things. Dalley gave me, for specimens, a Parrot-fish, two striped fish, and a Mackerel."

"June 20th, besides the purchase of a dredge, I got in all my supplies to-day, sieves, tubs, buckets, rope, etc., so that I am now ready for Wednesday, the first day of my steam-yacht engagement." From June 24th to July 14th, weather permitting, dredging and collecting were regularly carried out on fourteen days. Four days were lost through wet and stormy weather. At the end of the third week, the weather was so unsatisfactory, that, by arrangement, the fourth week's engagement of the steam-launch was postponed. From August 17th to 22nd the dredging was successfully resumed on six days, total 21 days. William Macleay was prevented by other engagements from going twice, but was one of the party on eighteen of the excursions. W. J. Stephens accompanied them on nine days, W. B. Dalley on three days, Captain Onslow and Captain Stirling, R.N., on one day, E. Damel on two days, and Mr. Davis on one day. The regular party consisted of William Macleay, G. Masters, J. Brazier and Tom Mulhall, or a substitute. with his boat, net and dredge, and once, in addition, C. Hastie with his boat and net. Two dredges were in use at first; but a third and heavy dredge, which was hauled by the steam-winch, was used after the first week. A shore-party, usually William Macleay and Masters, was landed as often as possible; the former collected marine forms, while the latter shot birds. Meanwhile dredging was attended to by those on the launch, or in the boat, and seining also by the latter.

During the first attempt, except on one day, dredging, etc., was successfully carried out in the Harbour and its branches, including Lane Cove. One day

was given up to dredging one and a half miles outside the Heads. The fourth week was to have been devoted to dredging and collecting in Botany Bay. This part of the programme was given up in consequence of a threatening gale, with a heavy sea. During the second attempt, three days were occupied in dredging outside the Heads. On one day, hauls were made between the Heads and off Manly; on another, from between the Heads to off Bondi; and on one day, off the Heads, in 25 fathoms. Twenty days were devoted to dredging, seining, shore-collecting, and the collection of both seabirds and land-birds, as opportunity offered, in Port Jackson and its branches, including Middle Harbour, Lane Cove, and the Parramatta River, below Gladesville. The entry for July 7th is—"We dredged the channel, three or four times, between Goat Island and Ball's Head, and got by much the greatest number of things we have ever had." And for August 22nd—"This was the last day of the steam-yacht; and I went out about 9 o'clock, accompanied by Stephens, Brazier and Masters. We went up the Parramatta River, as far as Gladesville, and dredged there for about two hours. Our success was greater than any day this week. We got some very large specimens of *Venus*, and other shells, such as *Trigonia*, etc., and took besides a few Crustaceans and Echinoderms. The dredging outside the Heads was not so successful; several times the dredge came up empty. Altogether a large miscellaneous collection chiefly of marine forms, was obtained, and much experience was gained."

(*c*) *Collecting and dredging in Jervis Bay and Port Stephens.*—Having made a good beginning with the Port Jackson fauna, William Macleay shortly after decided to go further afield. "September 19th. I find it so impossible to get a proper steamer for my proposed fishing-excursion to Jervis Bay., etc., etc., that I think now of taking the advice of Dr. Cox, and chartering a schooner." "October 3rd. I advertised in this morning's *S.M. Herald*, for a small steamer or sailing vessel suitable for a coasting excursion." "October 5th. I went to town at 10 o'clock this morning, to look at a vessel offered in answer to my advertisement. She is named the *Peahen*, is a ketch of about 30 tons, and is commanded by William Crichton. I think she will do for my purpose; and I am to give my final decision at 9 a.m. tomorrow morning." "October 6th. I closed with Crichton to-day about the ketch *Peahen*. On Thursday (Oct. 8th) I take her for two months for £90, the services of himself and two men given in. Brazier is to have charge, and is to have an assistant at £1 per week. They will be provided with food on board, for which I am to make an allowance. She is to go first to the south and Jervis Bay where Masters and I may meet her. I ordered to-day additional ropes, linen, and fishing lines; also spirits, jars, etc., and charts. Masters and I finished the Papilionidae to-day; they occupy twelve drawers; and commenced the Pieridae." After some delay, partly due to a southerly wind, the *Peahen* sailed on October 10th; arrived at Crookhaven River on the 11th, was detained for a week by bad weather, arrived at Jervis Bay on 23rd and returned to Sydney on November 6th, with a large collection, including sharks and other fishes, mollusca, crustacea, entozoa, etc., J. Brazier reporting that, in spite of unfavourable weather, he had dredged every part of Jervis Bay. After some delay, the *Peahen* sailed for Port Stephens on November 17th; got as far as Tacking Point on 23rd, but was compelled by unfavourable weather to return to Port Stephens; was at Nelson Bay on 25th; and again at Port Stephens on 28th, where a very large Sunfish (*Orthagoriscus mola*) was captured. The Entozoa were taken out and preserved. As it was desired to save the skin, the *Peahen* returned to Sydney on December 1st. The sunfish measured about

9 feet long, and 11 feet deep, including the fins. The skinning was a very troublesome job. The skin was afterwards stuffed and mounted, and kept in a small shelter erected in the garden. A considerable collection of marine forms, including a number of Comatulas, was obtained, but particulars are not given. As the time of the charter was not quite up, the *Peahen* spent three days (December 3rd-5th) cruising in Port Jackson for the purpose of dredging; and was paid off on the 9th.

(*d*) "*Fishing Picnics*".—Among the events worthy of note of this year, 1874, were five "Fishing Picnics", the object of which was to give pleasure, together with opportunities for promoting friendly intercourse and marine collecting. William Macleay was the host on three of these occasions. The other two were arranged by Captain Stackhouse, Honorary Secretary of the newly established Linnean Society of New South Wales, after it had got its name, and appointed its first Office-bearers and Council, but before it began to hold scientific Meetings, in January, 1875.

Of the first of these William Macleay says in his Journal—"April 4th, 1874. My fishing picnic came off to-day. The party consisted of Dr. Badham, Dalley, Stephens, Davis, Baillie of the Murrumbidgee, Captain Chapman, Forster, Masters and myself. Dr. Cox was prevented by a professional engagement from joining us. Our accompaniments were a North Shore steamer, two watermen's boats, George Mulhall and another, and a fisherman's boat with two fishermen. Jocelin, who supplied the edibles, sent a cook; and I brought my butler. Captain Chapman brought dredges, etc., and his coxswain to manipulate them. We got away from Circular Quay soon after 8 o'clock, called at H.M.S. *Dido* for Chapman, at Woolloomooloo Bay for the fishermen, and at Rose Bay for Dalley. We had a most pleasant day, which terminated at 6 p.m. I had with me two jars and a bottle of spirits, and collected many species of fish, mollusca, and crustacea."

The second picnic was given in honour of the scientific visitors on board H.M.S. *Challenger* then in port. Of this, William Macleay says—"April 19th. Cox and Stephens called in the forenoon. I arranged with them to give a fishing and dredging picnic on any day that would suit Dr. Wyville Thomson." The day that suited Dr. Thomson (Thursday) was not so suitable as a Saturday would have been for some of the invited guests who would otherwise have been present. "April 23rd. At 8 o'clock in the morning, I was at the North Shore Steam Ferry wharf, Circular Quay, to meet my guests for my fishing-party. In a short time, all were mustered; and having got our provisions, etc., on board, we made a good start. The party consisted of Professor Wyville Thomson, Mr. Murray, his Assistant, Professor Badham, Stephens, Onslow, Mackay, Masters, Dr. Cox, Forster, and myself. We were accompanied by the dredging steam-pinnace of the *Challenger*, Tom Mulhall and a fishing-boat with two men, which we picked up, by arrangement, off Woolloomooloo Bay. We called at H.M.S. *Dido* for Captain Chapman; and at Point Piper for Ned Hill, who brought with him a Blackfellow, and a lot of dynamite-torpedoes for fish. We had a very pleasant day, though our success in fishing and dredging was not great. We dredged, among other places, the deep parts of Middle Harbour above the Spit; found 18 fathoms of water, mud, and no life. We got back between 6 and 7 o'clock."

The *Challenger* naturalists gave a return dredging-party on June 3rd, mentioned later on.

The third of these festive gatherings was the first of the two "Linnean picnics" arranged by Captain Stackhouse. "November 21st. I went to a picnic of the

Linnean Society to-day. About twenty Members were present. We started from the Circular Quay at 10 o'clock, in a small and dirty steamer; and, after picking-up a fishing boat, etc., we fished Vaucluse Bay, the top of North Harbour and Quarantine Bay; and at the last of these we had our dinner. The party was, on the whole, a pleasant one. The catch of fish was small. At Quarantine Bay we got a good many White Trevally, pronounced, by those who ate some, a good fish; and a few Salmon, and Flathead. I got, for my collection, a Swimming Crab, a Salmon, and a small, barred Sole. Masters, who was of the party, got also, I believe, some small shells. At Quarantine Bay we saw a large Sunfish rolling about for some time. We got back by six o'clock."

On the fourth occasion, William Macleay was again the host—"December 5th. I gave a fishing picnic to-day in the steamer *Galatea*, two watermen's boats, Tom Mulhall and another, and Hasty's fishing boat. Supplies from Jocelin, and from home. The party consisted of Dr. Badham and an Italian artist, Dr. Cox, Faree of H.M.S. *Blanche*, Captain Chapman of H.M.S. *Dido*, Masters, Stephens. Dalley, E. Hill, Jennings, Stackhouse, Dr. Roberts, Ramsay, Phelps, Sandeman, W. Forster and myself, in all seventeen. We drew the seine in Quarantine Bay, the Bay next to it, and Collins Flat, and got a few Flathead, Bream, Whiting, and a number of Red Mullet. I got also two or three new fishes for my collection. We then steamed to Clontarf, landed, had dinner and amused ourselves until it was time to return. We arrived in Sydney at 6 o'clock after a very pleasant day. We saw the *Peahen* cruising about, but did not speak her."

The fifth was a "Linnean Picnic"—"December 19th. Masters came here in the morning; and at 9.30 a.m., he and I drove to the Circular Quay to join the Linnean Society's picnic-party, which was to start thence at 10 a.m. At 10.30 a.m. we got away, the steamer a very small and dirty one. The party numbered sixteen, including Ramsay, Brazier, Badham, Dalley, etc. We hauled the seine in Chowder Bay, Obelisk Bay, and above Shell Cove in Middle Harbour, where we had dinner. We did not get much either by the net or the dredge (we had Mulhall's dredge with us), but plenty of fish to eat, of good quality, which was skilfully cooked by Dalley. We got back to Circular Quay about 6.30 p.m., a good deal tired, and very much sunburned."

The above records are of interest because they are indicative of William Macleay's friendships before the Linnean Society of New South Wales was thought of, or, later on, before it began to hold scientific Meetings, in January, 1875.

3. *Land collecting.* (*a*) *Between Bondi and Botany Bay.*—So much time during the year was spent in routine work, and in marine collecting, that little time was available for land-collecting. Nevertheless five excursions for the day were made to La Perouse, and to Randwick and Maroubra, and Bondi by hansom-cab; the fauna of the old garden, before it was cut-up (in the following year) received much attention; and the larvae of indigenous Lepidoptera feeding on introduced plants in gardens, were collected and bred out (for at this time, only the first three Parts of Scott's "Lepidoptera" had been published).

The Journal records of these enterprises include the following—"May 16th. Masters and I left at 10 o'clock, in a hansom, and went to La Perouse's monument, but found the sea too rough for much to be done. We got a few shells, but scarcely anything else. We took a turn up on the hills, but found the scrub almost impassable. We got several lizards, and shot a *Ptilotis*." "June 3rd.

Masters and I went this morning, in a hansom, to Randwick and Maroubra, but not to the seashore. We walked over a large extent of country, but did not get much. Of birds I had not got, we saw only Bristle-birds and Emu-wrens, but failed to get any. We obtained only snakes, lizards, and frogs." "September 9th. Masters laid out the remaining Endeavour River Lepidoptera, and then, about 10 o'clock, he and I went out in a hansom to Maroubra Bay, and spent some hours on the hills lying between it and Long Bay. We got two kinds of snakes, four of lizards, etc., and a few insects. Masters tried hard to get a shot at Emu-wrens and Bristle-birds, both of which seemed abundant, but could not be seen. He shot a male of *Malurus Lamberti*, and a common Honeyeater. We got home about 3 o'clock." "September 13th. Masters and I went in a hansom at 10 o'clock along the road to La Perouse's monument. When about a mile from it, we left the cab, and went over the hills on the eastern side of the road. We got only one small snake, no lizards, and no insects worth mentioning. I found the nest of *Glyciphila fulvifrons* with one egg in it, which we took. The nest was in a bush, a few inches from the ground; a compact nest, very deep for its circumference. Masters, after a great display of patience, shot two bristle-birds, and two emu-wrens. We went on to the monument afterwards, to try to secure a fisherman, with his net, for Friday; but the men were too independent to treat with. We reached home at four o'clock." "September 18th. Masters and I went, at 10 o'clock, in a hansom as far as Bondi, on the old South Head Road; and then walked along the hills close to the coast until we came upon the road again, near the junction of the old and new roads, close to the Light-house, where we found our hansom. We got a large brown snake 5 feet 3 inches long, a small black one, a small diamond-snake, some lizards and some frogs. Masters also shot some emu-wrens; and I found a nest of *Glyciphila fulvifrons*, with two eggs. The brown snake had a large legless lizard in its stomach, all the bites or broken parts of which were covered with an entozoon, which was very numerous in the snake."

(*b*) *In the old garden.*—The old garden was to be cut up, and the greater portion of it offered for sale in the following year (1875). Incidentally much attention was paid to the fauna, other than the sections of it, especially insects and Arachnida, which for twenty-five years had interested William Sharp Macleay. Bats were captured in the cellar. Rats (especially the nest-building tree-rat described by W. S. Macleay as *Hapalotis arboricola*, then thought to be indigenous, but now regarded as a variety of the introduced Black Rat) and Bandicoots (one of them covered with ticks, small, large, and very large, and also a large species of flea) were caught in traps. A few birds of interest were sacrificed, including one of a community of Nankeen Night Herons (*Nycticorax caledonicus* Lath.) which for many years camped during the day, and nested in some of the old Pine-trees (*Pinus pinea*) near the house. Others, wanted for the collection, were *Strepera graculina*, *Meliornis*, the Oriole (*Mimeta viridis*), gulls and cormorant obtained from the beach at the bottom of the garden, a Pardalote and its nest, eggs of the Laughing Jackass, and Silver Eyes. Introduced Ring-doves of an Indian species had become very abundant in the neighbourhood of Sydney of late years. The earliest record of these undesirable introductions known to me is the following—"July 17th. Masters shot a pigeon, which turns out to be an Indian species, no doubt escaped from a cage. It was a fine full-plumaged female, full of eggs." And a week later—"July 24th. Masters shot another pigeon, of the

same species as the last, in the garden this morning." The skins of both were preserved. A Red-bellied snake, *Tetrodymon cucullatum*, frogs and slugs, and other invertebrates, some of them the progeny of species introduced with plants, were also obtained.

All the larger animals, especially, but not exclusively, vertebrates, obtained in the flesh, whether in the garden, on land-collecting excursions or on marine excursions, or by gift, were systematically examined for parasites, both Epizoa and Entozoa, and these were preserved. During the year 1874 alone, a very considerable collection was obtained, sorted, bottled and labelled.

(*c*) *Country excursions.*—William Macleay and W. J. Stephens, accompanied by G. Masters, who was then about to take his annual holiday, left Sydney on December 30th, 1873, on a visit to Wagga, returning on January 19th, 1874. The train then went no further than Goulburn. William Macleay sent up his own buggy, pair of horses, and coachman by train on the 29th. A second vehicle was hired. Stoppages for the night were made at Frankfield, near Gunning, Yass, Bogalong, Jugiong, Gundagai, and Lower Tarcutta, both going and returning. The weather was intensely hot nearly all the time. "The heat was so intense on the plains, that nothing was to be found under stones, and even the ground-beetles had ascended stalks of grass. The stones were too hot to touch." Nevertheless, collecting was carried out as far as possible in the early morning and in the evenings; and some important specimens were obtained. The birds were moulting, so that only half a dozen rare species were worth collecting. Masters met a local collector of birds and insects at Wagga from whom William Macleay, by purchase, obtained twenty-six of the species in the initial instalment of his ornithological collection.

Some interesting records of coastal species, which were rare inland forty-seven years ago, are mentioned: a few specimens of *Papilio sthenelus* taken at Wagga, "the only Papilio, so far as I know, in the Southern District". Also a few specimens of *Danais erippus* at Wagga and Goulburn—"The *Gomphocarpus*, its chief food on the coast, is not here, and I am not aware of any plants of the family Asclepiadae in this district." At Gundagai, "I noticed, on the river-bank, the rushes with very many of a species of *Asilus* (not of much size) hanging on the stems, each with a honey-bee (English) in his grasp, from which he had extracted or was extracting the vital fluids. It seems extraordinary, that an insect of this size should so invariably overcome a stronger, apparently, and certainly as large an insect as itself; but the fact is undoubted, and may account for the scarcity of the English bee in parts of the country, where it once seemed likely to become enormously numerous."

A second excursion by William Macleay and Masters, over some of the same ground, from Goulburn to Gunning, was made from October 15th to 19th, 1874. This was the second of the only two country excursions of this year. The weather was favourable this time, and a considerable collection was made, as much as they could bring back—birds, reptiles, amphibia, insects and other invertebrates. They were up at 5 a.m., and collected assiduously whenever an opportunity offered. "We became possessed of a blue heron in the most extraordinary way. It flew against the telegraph-wires, and broke its wing, just alongside the buggy."

(*d*) *Collections by E. Spalding.*—Early in June, William Macleay engaged E. Spalding for six months to make a general collection at the Endeavour River,

and, properly equipped, he left Sydney on June 10th. Spalding had previously collected insects for E. P. Ramsay, at Rockingham Bay, as mentioned in Mr. Scott's paper "On *Ornithoptera Cassandra*" (*Trans. Ent. Soc. N.S. Wales*, ii, p. 49). A first instalment of results was received on July 31st, comprising five boxes of insects, spirit-specimens of echini, crustacea, small mammals, fishes, asterids, and various small things; together with "skins of a new Bandicoot, and of about 20 birds, some of them new to Masters—altogether a good instalment." The second consignment of two cases was received on August 28th, of which "One case contained two boxes of insects, skins of eight species of birds, some Asterids, and twenty or thirty species of shells, some good things amongst them all. The other case contained a stone-jar, and seven or eight smaller bottles of spirit-specimens, including a good many fishes, some very fine Asterids, a few bats and rats, a number of lizards, and a large number of Crustacea, etc. Altogether, I am well satisfied with what Spalding has sent me as yet." The third came to hand on September 21st, two cases, "one containing skins of 17 birds, not in my collection—a Hawk, a Native Companion, a Spoonbill, an Oyster-catcher, and another—two of a species of Kangaroo, and a large iguana. The other contained a jar of spirit-specimens, rats, native cats, lizards, fishes, etc., etc., a very fair consignment". The fourth and fifth instalments, comprising insects only, were received on October 10th and 28th. "There were a few new things, but nothing of great interest", in the first of these; but the second included "a number of new things in the Elateridae, Cryptorhynchi, and Longicorns, the last being very fine". Spalding returned on December 7th, bringing with him "a good lot of insects, a few birds, a kangaroo, and some snakes and lizards, etc., in spirits. . . He has done well on the whole, particularly as regards the collection of insects."

4. *Exchanges.*—Important exchanges were arranged, and systematically carried out during the year. The subject is first mentioned in the Journal for February 9th.—"Masters is to write, for me, by the S.S. *Tartar*, which leaves on Saturday with the mails, via San Francisco, to Henry Edwards, to ask, now that regular communication is re-established, if he is disposed to recommence exchanges. He is also to write, with a similar object, to Mr. Waterhouse of South Australia, and Johannes Odewahn of Gawler Town." A few days later, letters were received from Mr. Crotch, of Cambridge, Mass., and Dr. Dohrn, of Stettin, making offers to exchange. These were accepted and, as soon as convenient, acted on. Other exchanges were arranged later. The total results for the year were:

Mr. Crotch, who was then working at the entomological collections in the Museum of Comparative Zoology at Harvard College, Cambridge, Mass., and was desirous of exchanging Coleoptera—a box of Australian Coleoptera, "228 species, mostly two specimens of each", was sent on April 10th. If any return for this was received, it was not noted in the Journal.

Dr. Dohrn, of Stettin—a small box of choice Coleoptera, received on August 25th. For this, two boxes of Coleoptera were despatched on November 27th; one containing "103 species of the choicest and rarest things I have, most of them named by myself." The second contained "about 50 species, nearly 200 specimens, of Endeavour River Coleoptera un-named; and about 45 species, 120 specimens, of South Country Coleoptera, also un-named".

Mr. Henry Edwards, of San Francisco—two consignments: one, received on July 2nd, of Coleoptera from California, Nebraska, Colorado, Indiana, the Atlantic

States, Mexico, and Vancouver Island; the other, received on October 6th, of "a large and fine collection of Lepidoptera, including a number of species new to my collection, occupying twelve cigar-boxes". For these and another promised, three returns were sent: one "of fine Diurnal Lepidoptera, for the most part from Endeavour River; 100 species of Australian Longicorns, all named; some *Tetracha*, *Hyperion*, and eight Buprestids, in all 110 species, about 400 specimens", sent on July 31st. The second, sent on November 19th, comprised "thirteen cigar-boxes with about 126 species of Australian Hemiptera, 180 species of Hymenoptera, 126 species of Diptera, and 70 species of Homoptera". The third, sent on December 21st, "A case containing two large boxes and one small one, of Lepidoptera, Sphingidae, Agaristidae, and moths, nearly 200 species in all".

Mr. Augustus Gross, of Newcastle—some Australian Lepidoptera (*Antherea*, Sphinges, and *Chelepteryx Collesi*, etc.) "bred by himself, and mounted with great neatness and care"; in exchange for Northern Butterflies, including Ornithoptera. "I also gave him a copy of Vol. ii, of the Trans. Ent. Soc. N.S. Wales". Mr. Gross paid three visits during the year. On his third visit, on December 26th, he received "some handsome foreign Butterflies. I also gave him a *Papilio Sarpedon* which had just emerged from its chrysalis, the last to come out of all those laid-up before winter".

Mr. James, Sydney—a box of very small Lepidoptera, collected at Baptist's Gardens; for which some large, showy East Indian Butterflies were given in exchange.

Mr. Pilcher, of Rockhampton—a good collection of Hymenoptera, Diptera, Hemiptera, Homoptera, and Orthoptera, containing more than 300 new species, received on August 27th. The box was refilled with "an equal number of New South Wales Coleoptera, properly named", as asked for, about 500 species, 1,500 specimens; and despatched on August 11th.

Mr. Augustus Simson, who had lived for some time at Port Denison, spent a short time in Sydney in August, on his way to Tasmania, where he thereafter permanently resided. About twenty species of land-shells and freshwater shells from Port Denison and Mt. Dryander were exchanged for New South Wales species. Mr. Simson called on William Macleay on August 25th. "Mr. Simson, who has frequently sent Mr. Masters things from Port Denison, and who is a most enthusiastic collector of insects, called this morning. He is going to his brother, near Hobart Town, probably to reside. From what he says, I think we may be mutually useful." This expectation was subsequently justified. On August 29th—"Mr. Simson came to get a lesson from Masters in skinning birds, and remained till 12 o'clock." On October 23rd, there is a record—"I had a long letter from Tasmania, from Mr. Simson in which he (says) much in the way of collecting; and sends a list of some shells, which he has sent to me, addressed to Mr. Brazier." On November 7th—"I got, this morning from Brazier, a box of Port Denison land and freshwater shells sent to me, through him, by Mr. Simson, now of Tasmania. They are, I believe, a very nice lot." Specimens of shells, in exchange for these, were sent on December 11th.

Mr. F. G. Waterhouse, of the South Australian Museum, Adelaide, had exchanged insects with William Macleay as far back as 1864, as narrated above. From 1874 onwards, general collections were exchanged. Two consignments were received and two were sent during the year. Of the first receipt, the record is—"June 9th. Mr. Waterhouse, of the S.A. Institute, sent me, through Masters and

by mail this morning, a box containing 32 species of South Australian birds, of which 23 were not previously in my collection. There were also a few Coleoptera, including a new *Cetonia* from the Northern Territory. They were all so infested with *Anthrenus*, that we had to put them in quarantine, with a strong dose of bisulphide of carbon." The second consignment, received on July 11th, comprised 36 species of birds from South Australia, Western Australia, and the Northern Territory, not previously in the Macleay Collection. An exchange for this, comprising rare birds, some spirit-specimens of small mammals, geckos, a young brown snake, and 25 species of shells, chiefly from Port Jackson, was sent on August 11th. The second, comprising a "box of choice Endeavour River Coleoptera, a box of Port Jackson shells, a pair of *Ptilotis Macleayana*, and of *P. Cockerelli*, and a jar of spirit-specimens of rats and lizards", was despatched on December 23rd.

5. *Donations.*—Over and above the sources from, or the ways in, which specimens were obtained as mentioned above, very important additions to the Collection accrued from donations from William Macleay's friends, from exchanges with correspondents in Australia, Europe, and the United States, and from extensive purchases of Australian specimens. The donors of specimens included:

Mr. J. Brazier—"A handsome donation for my Museum" consisted of a number of Crustacea, Asterids, and Echini from Port Jackson, Botany Bay, and the Howick group, N.E. Australia; of small fishes, etc., got in a towing-net in the Pacific; and of bottles containing lizards, fishes, etc., from Marshall Island, Eclipse Island, Bellinger River, Cape Sidmouth, Clarence River, Manning River, Fitzroy Island, and San Christoval, Solomon Islands (May 1st)—Specimens of *Bulimus Mastersi* and *B. Brazieri*, and of five species of Coleoptera from New Caledonia (May 11th)—Holothurians and an Asterid from Lane Cove—Specimens of eight species of Crustacea from the Mauritius (June 20th)—a Little Noddy, *Anous melanops*, shot in the Pacific Ocean near the equator, together with entozoa therefrom (June 22nd)—A large Asterid from the South Sea Islands; a *Spatangus* from the Solomon Islands, and several Port Jackson crabs and Asterids (July 10)—An egg of *Megapodius Brazieri* from Banks Island; and two eggs of the White Pigeon of the North—Specimens of *Ascaris* from the intestines of a fowl.

Mr. Bransby, "an enthusiastic fisher"—Specimens of two fishes—A Port Jackson Shark caught outside the Heads—A Cestracion Shark, a Kingfish, and a Nannygai.

Mr. Comrie, of the Currajong—Some shells from the South Sea Islands.

Dr. J. C. Cox—A collection of butterflies from Cape York; and spiders preserved in glycerine—An Asterid from Port Stephens, and three specimens of *Xylotrupes australinus* from Northern Queensland—"A handsome donation of specimens of quite 300 species of Shells chiefly from the South Sea Islands"—An additional donation of specimens of "over 100 species of fine shells" out of the duplicates in his collection; also an hydatid from a boy's liver—Specimens of small crustacea, echinoderms, etc., dredged on the *Challenger* dredging excursion (on June 3rd, which William Macleay was unable to attend)—An emu's egg, and a slow-worm—A gecko, a large centipede, a bandicoot, and a ring-tailed Opossum—An Asterid from Port Stephens, some small ringed snakes from Colo, "evidently the young of the Brown Snake", and freshwater fishes from Rockhampton, "about a dozen species, including three of *Silurus*"—Living geckos from Middle Harbour—Trematodes from the lungs of a sheep, from Mudgee—A young wallaby—A fine *Spatangus* from Port Jackson—A rock-wallaby from

Dabeo—Two flying-squirrels, etc.—A snake, *Diemenia reticulata*, from Port Stephens; and "a Chelifer got at the same house as one he gave me on a former occasion, taken off a woman suffering from Acariasis. No doubt the Chelifer was feeding on the Acari"—Snakes from Parramatta and Lane Cove—A fine *Syngnathus* from Cook's River, and a very curious lizard from the Darr River.

Mr. W. B. Dalley—Fishes (a magnificent Flying Gurnard; a Parrot-fish, two striped fishes, a Mackerel; fine specimens of Sergeant-Baker, Rock-fish, Parrot-fish and Leather-jacket; *Chironectes*).

Mr. W. Forster, M.L.A.—"An *Oodes* and a pair of *Feronia*, from Marrickville", on January 28th.

Mrs. Grigg (Lady Macleay's sister, resident in India)—a small collection of large Indian Coleoptera, from the Neilgherry Hills.

Mr. E. Hill—"A beautiful piece of *Gorgonia* taken yesterday (June 3rd) in the dredge" at the *Challenger* picnic.

Mr. Long—A bottle of sea-snakes.

Mr. G. Masters—A fine specimen of *Carenidium* or *Conopterum*, quite new, from the Richmond River—Specimens of three new species, of *Carenum*, *Feronia*, and *Psalidura*—A box of insects from the collection of friends residing at Rope's Creek. "There are numerous specimens of *Omma Stanleyi*, *Rhytiphora polymita*, *Stigmodera affinis*, a large species of *Cryptodus*, *Talaurinus* sp., etc., all insects considered to be rare until lately, and, consequently, excellent for exchange—"A donation of fine Lucanidae, of which I had no duplicates", for Mr. Crotch—Some Coleoptera from North Queensland, but nothing new—A skin of *Anellobia melivora* shot near Botany Bay—A well-preserved specimen of *Ostracion* from Port Jackson—A fine specimen of *Neptunus pelagicus*; and "one of *Catadromus Elseyi* from his own collection"—Three specimens of named Cryptorhynchs from his own cabinet; and a few quite new things sent to him from Mt. Dryander, near Port Denison; among them was a beautiful *Pachyrhynchus*—A wallaby, a Whistling Hawk, a Curlew, and a honeyeater, from the south side of Botany Bay—Some (about a dozen) Coleoptera from Treasury Island—A Goshawk, and Entozoa from a wallaby—Fishes, Crustacea, and a mollusc from Blackwattle and Johnson's Bays, taken in the seine—"A very fine specimen of a fish commonly known by the name of 'Maido' "—A donation of spirit-specimens of snakes, lizards, fishes, a tortoise, Arachnida and Vermes, chiefly captured by him at Rope's Creek—A fine specimen of an African Shell, *Bulimus Crossei*—A few fine shells—A fine specimen of *Turnix varius* shot near Waverley—A Samson-fish, and a Leather-jacket—A fine Tasmanian *Hippocampus*—A young Brown-banded Snake, and two nests, with eggs, of the Reed-Warbler, from Baptist's Gardens—Nest of *Melithreptus* sp., with a young cuckoo—Perch, Gudgeon, and Fortescue from Rope's Creek; and the nest, with eggs, of *Malurus cyaneus*.

Mr. H. N. Moseley (of the *Challenger* scientific staff)—an egg of *Diomedea chlororhynchus*.

Captain Arthur Onslow (grandson of Alexander Macleay)—A *Porphyrio* from Camden—His fine collection of shells, some "of considerable size, and American species, which I had not got"—A fine living Planarian from the hot-houses at Camden (possibly *Bipalium Kewense*).

Mr. Phelps—A large number of insects collected by him on the Darling, including some fine specimens of *Euryscaphus* and *Zuphium*; and two specimens of a freshwater shell, also from the Darling—Specimens of a freshwater

shell from the Murray River. "Mr. Phelps tells me that he thinks he took the fine *Euryscaphus*, in the Darling River collection, at night, at the door of his hut".

Captain Stackhouse—Some Crustacea dredged by the *Challenger* dredging-party on June 3rd—Coleoptera from New England, collected by him, during a visit of some months.

Mr. W. J. Stephens—A Cestracion Shark from Manly.

Mr. G. Deas-Thomson—An Ailanthus silkworm moth.

6. *Purchases.*—When William Macleay made his offer to the Senate, in 1873 to bequeath the Macleay Collections to the University, he said—"The Zoological Collection which I leave to the University, comprises very few specimens of the vertebrate animals, and except as far as Australian species are concerned, it is not likely that I will attempt to add to it."

It is evident from this, that even at this time, before his appointment of a Curator, he had some idea of adding Australian vertebrates; and, in January, 1874, he began to do so, especially birds. But within the next four months, he was getting so interested in the enlargement of the collection, that he decided to begin adding non-Australian vertebrates to the collection, in this case also beginning with birds. The record for April 12th is—"Wrote letters all this morning. I wrote to Mr. A. Boucard (a dealer in natural history specimens, in a large way, in London) giving him an order for 1,000 species of (foreign) birds. I wrote to my brother Alick (in England) about the same matter."

Very important additions to the Collection were made by purchases throughout the year. During William Macleay's visit to Wagga, with W. J. Stephens and G. Masters, in January, 1874, he met with a local collector of birds and insects, named West, from whom twenty-four skins of birds, and some fine specimens of *Stigmodera*, two new species among them, and a fine new *Rhytiphorus*, were purchased. A few other bird-skins were obtained by the party. On January 26, the bird-skins, representing 35 species, were put away in a drawer. "This is the commencement of my ornithological collection." The following is a list of those from whom purchases were made during the year:

Mr. A. Boucard, London—A collection of 850 named and labelled bird skins (1,000 were ordered), almost all small, and chiefly from South and Central America, very few European species, but 20 or 30 Australian (nine not before obtained); 78 species of Trochilidae, with the sexes of 50 species, were received on October 28th. On November 6th, part of the entry in the Journal is—"I finished (that is sorting and marking them off in Gray's Handbook of Birds) with the birds to-day. The total number of species in Boucard's collection is under 650 species. My total in all is about 980 species." On November 16th, a second order was written, and posted on the 27th—"I wrote to-day to Boucard, London, about the birds and ordering more; that is desiring him to complete the last order of 1,000 species and ordering another 1,000 species. I have also ordered small mammals, and reptiles and fishes in spirit. I have asked him also to get as many species of the genera *Leptalis* and *Euterpe* of the Pieridae as he can."

Mr. J. Brazier—470 species of Mollusca, on August 8th—378 species, including species of *Helix*, and Volutes on September 12th—"A fine collection of over 70 species of Crustacea, and about 20 species of Echini and Asterids, from New Caledonia, on April 20th—Three species of mammals, 19 of birds, six of fishes,

29 of Crustacea, and 6 of Radiata, from Mauritius and Madagascar, purchased at an auction sale, on April 22nd, 270 species "new to my collection", on September 24th.

Mr. E. Damel—a collection of 48 species of land-shells from the Philippine Islands; and 11 species from New Granada, on June 2nd.

Mr. Duboulay—A collection of about 500 insects, a few land shells, and half a dozen bottles of spirit-specimens of snakes, lizards, etc., from the Endeavour River, on May 21st. "There were some very fine, and new things among the Coleoptera."

From, or per medium of, Mr. G. Masters—A collection of bird-skins, 138 specimens, representing 85 species, some rare, on February 24th—A small collection of spirit-specimens of small mammals, lizards, and snakes, etc., from Salt River, in the interior of Western Australia, on June 2nd—Eight fine skins of Pigeons from the Richmond River, on June 11th—Forty specimens of *Tetracha crucigera*, 60 of *Hyperion Schroeteri*, and eggs of 28 species of Australian birds, on August 27th—A collection of Moths, chiefly Micro-lepidoptera, 1,000 specimens, probably 400 species, made about Sydney, on November 17th; "they are chiefly intended to send to Mr. Edwards, of California".

Mr. Palmer, a taxidermist, and dealer in natural specimens, whose shop was in Hunter Street.—130 bird-skins, including 36 from Cape York, 2 lizards from the Richmond River, a kangaroo rat, a stuffed mongoose, and the complete skeleton, not articulated, of an aboriginal female. On June 23rd, William Macleay came to an agreement with Palmer, undertaking to purchase any specimens of birds not already in his collection, at a fixed rate.

Mr. Petterd—A collection of 53 species of land and freshwater shells from the Richmond River, on September 7th, "some very minute, and nearly all new to my Collection."

Mr. E. Waller, Brisbane—a collection of 62 specimens of Australian bird-skins, 48 species, on May 22nd.

(ii.) Offer to University of Library and Collections.

The Chancellor, Sir Edward Deas-Thomson, announced William Macleay's offer of the Macleay Collections, as a bequest, to the Senate of the University, in his Address delivered at the Commemoration on March 28th, 1874. The Address was published in the *Sydney Morning Herald* of March 30th. The portion of it relating to the offer, is as follows:—"I have much pleasure in stating that a communication has been received from William Macleay Esqr., M.L.A., F.L.S., announcing his intention of bequeathing to the University his valuable (scientific) library and collection of natural history, upon trust for the promotion of that science, and the instruction of the students and the inhabitants of the colony in the same, and upon certain conditions set forth in his will, of which he sends an extract. He also expresses his intention of leaving to the University the sum of £6,000 to be invested in Government securities of the Australasian colonies in this colony; the interest upon which is to be applied to the payment of the salary of a properly qualified curator, to be specially and exclusively employed in the care and preservation of the specimens belonging to the collection, or any additions that may be made to it. The library already consists of about 2,000 volumes, and Mr. Macleay states that he is continually adding to it. . . . It includes a large number of books on Natural History, which belonged to the late William Sharpe Macleay Esqr., F.L.S., and which have

been presented by his brother, George Macleay Esqr., C.M.G., F.L.S., to accompany the collection. Of the collection of specimens, I believe it may be confidently asserted that it is one of the most extensive and valuable in the world (i.e., in the possession of a private individual)."

The continuation of his Commemoration Address had reference to the importance of Natural History in dealing with fungoid and insect pests, some of them troublesome in Australia and elsewhere just then.

Mr. Deas-Thomson (1800-79), member of the first Senate, Chancellor from 1875-78, came to Sydney in 1828, and succeeded Alexander Macleay as Colonial Secretary in 1837. He married the second daughter of Governor Sir Richard Bourke in 1833. He lived at "Barham", off William Street, about ten minutes' walk from Elizabeth Bay House. From William Macleay's Journal I learn that the members of the two families constantly visited, and in fact, dined on alternate Sundays at "Barham" and Elizabeth Bay House. Sir Edward had numerous opportunities of seeing and learning something about the Macleay Collections.

Though not professedly scientific he had a general interest in Science. He was a member of the first Committee of the Australian Museum appointed in 1836, and eventually succeeded Alexander Macleay as President. He was a Fellow of the Linnean Society at least as early as 1838.

The significance of William Macleay's offer to the Senate in 1873, seems to be: firstly, that the Chancellor was looking forward to the establishment of a Medical School in connection with the University, and he thought that the announcement would help to stimulate an interest in the matter, and, secondly, that it would help to settle the question of the locality for the erection of the contemplated Prince Alfred Hospital.

Melbourne University founded in 1853, three years later than Sydney University, had a Medical School to begin with, and zoology was included in the curriculum. The Alfred Hospital in Melbourne was opened by the Duke of Edinburgh in 1870; and the foundation stone of the Prince Alfred Hospital in Adelaide was laid in the same year. But though the money had been in hand for several years, the foundation stone of the Prince Alfred Memorial Hospital, Sydney, was not laid until April 24th, 1876, one reason being that there was not unanimity as to a site for it. If the University was to have a Medical School there would need to be a suitable hospital in proximity to it. The Chancellor may have wished to see it erected where it now is. An important hospital is a necessary adjunct to a Medical School.

But it was not of any particular importance to William Macleay, that his intention should have been announced in 1874. What happened in his case was (i) that the announcement aroused considerable interest, and his friends began to offer him donations of specimens; and (ii) that he had now committed himself to the eventual disposal of the collections. But what happened in 1874 was for the most part unforeseen when he made his communication to the University towards the end of 1873.

(iii.) The visit of H.M.S. *Challenger*.

H.M.S. *Challenger*, in command of Captain Nares, arrived in Sydney on April 6th, and sailed again on June 8th. The scientific staff included Professor Wyville Thomson, leader, John Murray, physicist, H. N. Moseley and Dr. von Suhm, zoologists.

In anticipation of this visit, William Macleay notes in his Journal on January 24th, that he had begun to read Wyville Thomson's interesting book on the deep-sea investigations carried out on H.M.S.S. *Lightning* and *Porcupine* in the summers of 1869-71. The book was finished next day and promised, on loan, to Mr. Deas-Thomson. The *Challenger*, at this time, according to the programme, was supposed to be in the Antarctic regions, and was expected to arrive in Sydney about May, to refit.

William Macleay made the acquaintance of Wyville Thomson on April 7th, at the Club. On the 12th (Sunday) he records—"I went to 'Barham' to dinner, where I met Professor Wyville Thomson and Captain Maclear. They afterwards came on here, and we had a most scientific party, consisting, in addition, of Roberts, Stephens, and Sandy Macdonald."

On 19th April the record states—"Cox and Stephens called in the forenoon. I arranged with them to give a fishing and dredging party any day that would suit Wyville Thomson." The party was fixed for the following Thursday. The record of it is given above (p. 226).

Masters went, on April 25th, on the invitation of Mr. Murray, to see the collections on board the *Challenger*. In the evening of the same day William Macleay "went to dinner with Captain Nares and Professor Wyville Thomson on board the *Challenger* at 6.30 p.m. The party consisted of Onslow, Badham, Hill, Cox, Morris, Captain Chapman and Captain Maclear and myself. We had a good dinner, spent a most delightful evening, and had a look at some of the curious things collected. It was 11 o'clock before we left."

On the following afternoon the visitors to Elizabeth Bay House included "Onslow, Badham, Stephens, Davis, Cox, and Murray of the *Challenger*".

Dr. Crosbie and Dr. W. von Suhm, both of the *Challenger*, called on April 30th—"They both take an interest in, and show some knowledge of, entomology. I showed them some of my collection, and we had a general talk about Crustacea and other marine animals, these being the things Dr. von Suhm has chiefly studied."

Mr. H. N. Moseley had been away in the country for part of the time, the guest of Sir William Macarthur at Camden Park. On his return, he called on William Macleay, and stayed to lunch, on May 6th—"Mr. Moseley, one of the naturalists of the *Challenger*, came here about 11 o'clock, and remained till 2 p.m. He is a very intelligent man, with a general knowledge of Natural History. He seemed to enjoy looking over my collection."

The Officers and Scientific Staff of the *Challenger* gave a ball on May 8th. Dr. Badham gave a dinner on May 14th, the guests being "Captain Nares, Captain Maclear, Dr. Alleyne, Captain Stackhouse, Cochrane, and myself."

Captain Nares was to have dined at Elizabeth Bay House on May 17th, but was unable to do so. Mr. Moseley came to breakfast on May 21st. "He brought me an egg of *Diomedea chlororhynchus*. I gave him three bats, some of their parasites, a Stylopised wasp, and a male *Psalidura*, as he wished to examine the forfex."

William Macleay met Wyville Thomson again, in town, on May 29th. The Professor had just returned from a successful and enjoyable trip to Queensland; three specimens of *Ceratodus* were procured. In the evening, the Australian Club gave a dinner to the Officers and Scientific Staff of the *Challenger*.

On June 1st, Professor Wyville Thomson, accompanied by Mr. Deas-Thomson, made a visit to the University, and afterwards came to Elizabeth Bay House

to lunch. "We had also W. A. Dumaresque and the Rev. Mr. Stanley of H.M.S. *Pearl*. I showed the Professor a number of things."

The *Challenger* naturalists gave a dredging-party on June 3rd. William Macleay had a prior engagement, and was unable to join the party. Captain Stackhouse and Dr. Cox afterwards gave William Macleay some of the specimens, obtained by the dredge, offered to the guests.

William Macleay met Wyville Thomson in town on June 5th. The following day, Dr. von Suhm came to lunch at Elizabeth Bay House. "I had a good talk, and looked over the crustaceans and insects with him."

For June 7th the record is—"The party this afternoon consisted of Deas-Thomson, Stephens, Davis, Dr. Badham, and Professor Wyville Thomson, who came to say good-bye, as the *Challenger* positively leaves to-morrow". The vessel sailed on the following day.

To go back for a moment, on April 24th, William Macleay notes—"In the afternoon, Masters and I looked over and named some insects in a collection of Richmond River things which Dr. Wyville Thomson sent for my inspection." The examination was continued on the following day. For April 27th, the record is—"Professor Wyville Thomson sent me, this morning, for inspection, a number of bottles filled with Australian Coleoptera. Masters and I looked them all through, and found them to be only duplicates of the Richmond River collection sent a few days ago, with the exception of a few Western Australian things which we separated from them." The naming of the collection was continued on the following day, and completed on April 29th. On June 2nd, it is noted that, "I sent Professor Wyville Thomson's boxes on board to-day, and sent with them two cases of my wine (red, 1871)", the product of his vineyard at Lake Albert, near Wagga.

The visit of the *Challenger*, and the opportunity which it offered for friendly intercourse and hospitality, was most enlightening and stimulating to the naturalists and other scientific men of Sydney; and was an inspiriting experience to William Macleay in the way of further development of his collection, especially in regard to marine forms.

(iv.) Proposal to establish a Natural History Society.

The records in the Journal dealing with the proposal to form a new Society towards the end of 1874 have been given in the Presidential Address by Dr. T. Storie Dixson (PROCEEDINGS, 1904, p. 8).

(v.) Resignation from Parliament.

As the year advanced, William Macleay became more and more deeply immersed in his scientific enterprises. The prospective Linnean Society of New South Wales promised additional, unexpected and unrealizable responsibilities, from October onwards. He began to realize accordingly that he had so much in hand, that it was becoming desirable to curtail some of his engagements in other directions, especially in regard to politics, which made the largest demands on his time and energy. He had completed about twenty years' service as a Parliamentarian, from May 22nd, 1856, as a Member of the Legislative Assembly during seven consecutive Parliaments, ever since the establishment of Responsible Government; and before this in the old Legislative Council, from 1854-56. He was unwilling to put his constituents to the trouble of an election during the life of Parliament. But on November 25th, a political crisis arose. "Mr. Combes carried

his motion to go into Committee tonight by a majority of two, 28 to 26; and, in Committee, carried a Resolution by a majority of one; but, when reported to the House, it was rejected by the casting vote of the Speaker. Mr. Parkes (the Premier), however, said he accepted it as a defeat, and adjourned the House." Parliament was prorogued by proclamation next day. The Journal records—"November 26th. I have made up my mind not to offer myself again; and, as soon as the dissolution is proclaimed, I shall send an Address to the Electors of the Murrumbidgee telling them so. I intend to give my attention henceforth entirely to Natural History, and the improvement of my Museum." The Assembly was dissolved by proclamation on the 28th. The Address to the Electors appeared as an advertisement in *The Sydney Morning Herald* on 30th November. Much regret at his retirement was expressed personally, as well as by letters and telegrams; and he was urged to reconsider his decision, but courteously and steadfastly declined. Mr. William Forster, a squatter as well as a politician, with William Macleay's support, was elected to fill the vacancy.

1875.

The overhauling and rearrangement of the Macleay Collections, and their development into a general collection, initiated in the previous year, involving much routine-work, was strenously continued as far as possible during the year 1875. The Linnean Society of New South Wales entered upon its scientific career in January, necessitating additional responsibilities for William Macleay, at a rather inconvenient time, when he was busy with other matters. But the most important event of the year was his expedition to New Guinea, earnest preparations for which began immediately after his purchase of a vessel on February 26th.

Routine work, save for necessary interruptions, was systematically continued. The general trend of it is indicated by several out of many entries in the Journal. "January 1st, 1875. Neither Masters nor I made a holiday of it, and we were joined in our work by Stephens. It consisted of bottling and looking over Asterids, &c., from the Endeavour River, and in looking over a cabinet of dried fish, part of the W. S. Macleay collection. . . . Stephens left after luncheon; and Masters and I marked (in Gray's Handbook) all the Australian birds still desiderata. I must now have about 400 species out of about 660 in all." "January 8th. Masters and I put out in order all the Australian Zygaenidae." "January 15th. Masters and I put aside the birds I purchased yesterday (94 specimens, from Palmer). We then laid out the drawers of Australian Lithosiidae and Arctiadae." The Liparidae, Bombycidae, Cossidae, Hepialidae, were next taken in hand, and finished with on February 23rd. "March 11th. Masters and I were, for most of the day, arranging and naming the foreign Lycaenidae (*Thecla*); we got on very poorly at it." Before this group was finished, and the foreign Hesperidae and Australian Micro-lepidoptera taken in hand, this branch of the routine-work was temporarily suspended, until after the return from New Guinea. But besides this much time was consumed in putting away collections received, and in preparing collections to be sent as exchanges.

Meanwhile, part of the entry for February 5th may be mentioned. "This day completes the first year of Mr. Masters' curatorship; and I think that the additions to my museum during that time have been very large indeed. I have now over 1,000 species of birds, of which 395 are Australian. There is a fine collection of fish. The reptiles are rapidly increasing. A large number of specimens from the

Endeavour River, California, &c., have been added to the entomological collection. While of shells and marine animals, we have accumulated a vast number."

Important additions were made by donations, exchanges, purchases, as well as by the efforts of William Macleay, Masters and Spalding, before the expedition to New Guinea started in May.

Donations of a miscellaneous character were received from—Mr. H. H. B. Bradley (a very large brown snake and two lizards)—Mr. Brazier (sixteen eggs of a Tern, from Treasury Island, one of the Solomon Islands; specimens of *Syngnathus* from New Caledonia and the Solomon Islands; some donations, chiefly minerals from New Caledonia)—Dr. Cox (a second specimen of *Silubosaurus* from the Darr River, and a sea-snake and a lizard from the Lifu Islands; a living Echidna, and two small lizards and three species of small fishes from the New Hebrides; a living young *Ornithorhynchus*, and the viscera of an iguana, which yielded two species of nematodes; two gudgeons from Mulgoa, and a *Chironectes*) —Mrs. Glover, Port Stephens, per Mr. Brazier (a green treesnake, and *Vermicella annulata*)—Mr. G. Masters ("a beautiful fish quite new to me, and two young Samson fishes; and a number of other fishes caught by him from the jetty)— Captain Onslow (a living specimen of *Podargus humeralis* from Camden)—Mr. E. P. Ramsay (four specimens of *Ornithoptera Cassandra*, "promised for years"; a fine specimen of *Ceratodus miolepis* from the Mary River, "quite distinct from *C. Forsteri* of the Burnett River")—Mr. Stephenson (a small ringed snake)—The carpenter of the *Chevert* (two small living turtles from Singapore).

Exchanges during the year were carried out with:

F. and H. W. Bates, of London—one small box of Heteromera from the former; and another, chiefly Carabidae from the latter; "both contained some newly described species"; received April 15th.

California Academy of Sciences—a box of 137 species of mollusca "from various parts of the Pacific"; received on April 5th. "Brazier was here in the afternoon and commenced preparing a return box of shells", about 160 species, sent on April 9th.

Dr. Dohrn, Stettin—"April 9th. I had a letter from Dr. Dohrn, who seems delighted with the insects I sent him." Two boxes of Coleoptera received (receipt noted on October 11th). "Dohrn's boxes contain some good things."

Henry Edwards, San Francisco—four consignments: (*a*) A box of insects; "it contains some very choice Diurnal Lepidoptera"; received on January 27th. (*b*) "Three small boxes of Coleoptera, three or four of shells, and some small bottles of Crustacea, Julidae, &c."; received on February 25th. (*c*) "A small box of beetles (Malacoderms), and one of shells"; received March 18th. (*d*) Lepidoptera (receipt noted on October 11th, without further details). Two consignments were sent in return: (*a*) A box of rare, northern, diurnal Lepidoptera, (*b*) "Two small boxes of phytophagous Coleoptera, about 160 species"; sent on April 9th.

Augustus Simson, Hobart—A parcel of Mollusca, 57 species, and some lists of names of others, was sent, on January 18th, in exchange for shells received in the previous year.

Important additions by purchase, include the following from:—

Mr. Brazier—about 150 species of Mollusca "not in my collection, and some Crustacea from New Caledonia"; February 10th.

Mr. Gruber, San Francisco—Two consignments: (*a*) A box of Californian bird-skins, 100 species, "among them some valuable specimens; a few, too large for the drawers, were packed away in a case in the small room of the library";

received February 12th. (*b*) A large box of bird-skins; "some valuable birds from the Arctic regions, the Pacific, and from Arizona, mixed with some common enough things"; receipt noted October 10th.

Mr. Boucard, London—a second instalment of 800 birds (which arrived during the period when the Journal was not kept. Noted without further particulars, January 26th, 1876).

Mr. Duboulay, Perth, W.A.—a box of insects, received April 2nd. This was set aside, unopened, pending further information; and is not mentioned again.

Mr. Palmer, Taxidermist, Sydney—At different times, up to April 24th, 88 skins of Australian birds, some new to the collections, and others duplicates for exchange purposes; 30 Californian birds; and two cases of mounted Samoan birds, including *Didunculus*.

Mr. C. Pearce—a good collection of birds from Fiji. Three new species from this collection were described, and the whole collection (37 species) catalogued by E. P. Ramsay in his paper "Remarks on a Collection of Birds lately received from Fiji, and now forming part of the Macleayan Collection, at Elizabeth Bay; with a list of all the species at present known to inhabit the Fiji Islands" (Proc. Linn. Soc. N. S. Wales, Vol. i, Part i, p. 69; read December 27th, 1875. See also p. 44.).

Mr. Waller, Taxidermist, Brisbane—16 birds, 13 of them new to the Collection; received January 27th.

Mr. West, Wagga—10 birds; received January 4th and 24th.

Mr. Webb, King George's Sound—Two consignments: (*a*) 30 mammals, and 90 birds, some large, as Emus, received on February 16th; "a very good lot; about 25 species of the birds and all the mammals were not previously in my collection". (*b*) A second lot of mammals (9) and birds (12), "two of them new to my collection", together with spirit-specimens of snakes and lizards.

Mr. Masters purchased, from local collectors, 10 species of birds, mostly from Cape York, a Cuscus, and a Koala, on January 9th; and other small lots.

But there were others, besides the above mentioned, without being specified, in the entry for January 26th, 1876.

E. Spalding left early in the new year for Queensland. The Journal entry for December 31st, reads—"Spalding called in the morning. He seems anxious to go on another expedition, and I think I shall humour him. He thinks that a new settlement just forming on the Daintry River would be a good place." "January 7th. I saw Spalding to-day. I have arranged with him to go for a few months to Townsville and contiguous places." On January 11th he came, and "packed his vats, jars, cases, &c.", and left by steamer for Townsville on January 18th. A first instalment of results was received on March 18th: "a number of good bird-skins, only three, however, of species I had not got; two boxes of insects, the Coleoptera not differing from those of Port Denison, but the Lepidoptera (Moths) very fine; and spirit-specimens of Entozoa, &c., snakes and lizards, some of these last evidently new species". Three days later a telegram from Spalding announced that he had an attack of fever, and had decided to return. He arrived on April 5th, in a very weak state, bringing the rest of his collection "a few birds, a Jabiru and two Finches, being the only novelties". "May 3rd. I saw Spalding to-day. He still looks very ill. He wishes to go with my expedition; and, as Dr. Cox says it will do him good, I will take him."

No land-collecting, or shore-collecting of importance was attempted, but important additions were made to the ichthyological collection. "January 22nd.

In the afternoon there was an extremely low tide. Masters, Brazier, and I went down to the Bay, and waded about for some time, but we did not get much." "January 23rd. Hastie hauled the beach here about 7 p.m., low water but rising. He had a wonderful haul of bream, yellow-tail, stingrays, &c.; these last seemed to have numerous young in a foetal state. I secured one or two good fishes, and a *Neptunus pelagicus*, of which there were at least a dozen of a good size."

Between January 4th and March 18th, seventeen early-morning visits were made to the fish-market at Woolloomooloo. William Macleay went alone twice, and twice with Masters; the latter went alone thirteen times. From this source, a number of specimens wanted for the collection were secured, including an Angel-shark, "the first I have seen", a number of others "new to me", some large crabs, and a small turtle. Also "a fine specimen of *Elacete nigra* or a new species, the King-fish of some fishermen. Dr. Alleyne and Stephens came to look at it, and stopped to luncheon". One of the fishermen brought a large numb-fish, or Electrical Ray, and a Squilla.

On five evenings Masters fished from the jetty, and got some desirable specimens, including *Batrachus dubius*, *Chiloscyllium*, *Plectropoma ocellatum*, and a Stingray "which was delivered of some good-sized young ones while lying on the jetty". On one occasion William Macleay joined him.

The Chevert Expedition.

The great event of the year 1875 was William Macleay's expedition to New Guinea, during which he was absent from Sydney from May 18th to October 11th. He must have had some such project in his mind for some time; and apparently his intentions had been communicated to some of his friends. The earliest records in the Journal in any way bearing on the enterprise are—"October 3rd, 1874. Dr. Cox called this forenoon to speak about a collector in Torres Straits": and "October 30th. I had a letter from a Mr. Webber, an old steamship-skipper offering to sell me his shells, and to command for me any vessel I may fit out for a scientific cruise."

Inspection of, or inquiries about, a steamer and two barques advertised for sale were made. The sum of £4,000 was asked for the steamer, and £6,000 for one of the barques; the accommodation afforded by the second not being satisfactory. A small steamer (probably the *Thetis*) for the Government, on the stocks at Cockatoo Island, was visited in company with Mr. Moriarty. After seeing this vessel, and his inquiries as to cost, William Macleay records on November 14th, "I suspect that I shall not be able to get a decently large steam-yacht under £4,000".

The record for January 5th, 1875, is more explicit—"Dr. Cox called to-day with Captain Edwards, an old sea-captain well acquainted with Torres Straits and the South Sea Islands. I had a long conversation with him. He is to look out for a vessel for me suited to my proposed trip to New Guinea." As the result of Captain Edwards' inquiries, several vessels, including a handsome brig of 300 tons, were inspected on January 12th, without results, as either the passenger accommodation was unsatisfactory, or the price was very high. Captain Edwards was therefore instructed, on January 14th, to advertise for a vessel for charter. "January 19th. I went to town early to call on Captain Edwards. We find it almost impossible to get anything suitable". Two vessels were inspected on February 8th and 10th, and an offer was made for one of them, but declined. On February 19th, a brig was inspected, but she was not satisfactory. Finally, on

February 20th, Captain Edwards reported another barque, which was inspected on February 22nd. "With Captain Edwards, I went across to Mort's Dock and looked at the barque *Chevert*. She is large and strong; and if the marine surveyor's report is favourable, I shall try to buy her." On February 23rd, a very favourable report was received from, and discussed with, the surveyor; and the result was that "I authorised Edwards to offer £3,000 for her". The owner wanted more, but eventually accepted the offer. "February 26th. I met Captain Edwards at the Club. He announced that he had completed the purchase of the *Chevert* for £3,000. I gave him a cheque for the amount; and he takes possession to-morrow." The new owner, accompanied by "Davis, Stephens, Masters and Captain Edwards visited the ship next day. A second mate and four Rotumahan sailors were placed in charge of her". "We settled what carpenters' work is to be done, and are to get an estimate on Monday. I shall now probably start a month sooner than I intended, and give up my Murrumbidgee trip." On March 1st, "I met Captain Edwards at Mitchell & Co.'s about the ship. We went to the Custom House, where I made a declaration that I was a British subject, and the owner of the *Chevert*". "March 4th. I went to town early and took Captain Onslow to see the ship. He likes her exceedingly." The alterations in the way of improved cabin accommodation at a cost of £140, were approved of, and ordered to be completed without delay. The carpenters having all but finished on March 15th, a ship's carpenter was engaged to do the rest. On March 18th, the vessel was towed to an anchorage in Elizabeth Bay opposite Elizabeth Bay House. Thereafter, ballast not required was landed by lighter at the jetty; and the ship made ready to receive stores, coal, forage, and equipment for the voyage.

Captain Onslow's approval of the vessel was important, because he was to be a passenger, in the capacity of William Macleay's companion and nautical adviser. As mentioned above, Captain Onslow was Alexander Macleay's grandson; and as Lieutenant had served on board H.M.S. *Herald*, a sailing-ship, under Captain Denham, when carrying out survey work on the Australian Station, off the Great Barrier Reef, in Torres Straits, as well as on the west coast. He and William Macleay were close friends, both Trustees of the Australian Museum and for some years prior to William Macleay's resignation in November, 1874, both Members of the Legislative Assembly. Moreover, Captain Onslow was interested in Natural History, especially in Conchology, and the donor of his collection of shells, and of other specimens to the Macleay Museum.

Meanwhile, besides the question of stores, and other supplies, much time and energy were devoted to providing a steam-launch. "March 5th. I went this morning with Captain Edwards to look at some steam-launches, but saw none to suit." After further fruitless inquiries and inspections, it was decided, on March 11th, to accept two offers from contractors, one to build the hull, and the other to construct the engines, the work of both to be completed in six weeks. Seven weeks later the launch was still unfinished. "April 29th. The delay in building the steam-launch will probably make it after the 12th of next month before we get away." Eventually she was delivered on May 17th, three weeks late; was got on board the same day, not without difficulty; and the *Chevert* sailed the next day.

On the Monday (March 1st) after the delivery of the vessel was completed (on Saturday, March 27th), the outfit was taken in hand. Captain Edwards was to command the *Chevert*; and, therefore, was consulted, and accompanied William Macleay to various business establishments. The Journal, from day to day,

records extensive purchases, including—ten iron tanks for water, coal, provisions, stores, vegetables, forage, furniture, linen, bedding, arms, ammunition and accoutrements, nets (including a seine, 60 fathoms long and 18 feet deep, together with a trawl-net, &c.), dredges, lines, fish-hooks, fish- and rat-traps, sieves, harpoons, bottles, tubes, tanks, boxes, spirit and et ceteras for specimens, medicine chest and necessaries, a large assortment of "trade" for bartering for specimens, stationery, books, &c.

On April 20th the Journal records that great progress has been made on board the ship to-day; most of the water has been supplied; and a large lighter is alongside, unloading provisions, &c. Some of the entries towards the end of April onwards to the date of sailing are interesting. April 27th—"Masters continues getting things ready for my expedition. It ought to be well found in everything, judging from the bills that are coming in." "April 30th. I am anxious to know all my liabilities." "May 14th. I wrote some huge cheques to-day." "May 15th. I paid nearly all my bills to-day", and the rest were paid the next day.

Purchases were supplemented, in a very pleasing manner, by gifts or loans from friends. Sir William Macarthur, of Camden, in response to William Macleay's offer to take one or more plant-collectors, equipped and sent two of his gardening staff, Messrs. Reedy and Dingwall, to collect botanical specimens, and bring back living plants in Wardian cases. "April 1st. Sir William Macarthur came to luncheon, and I had a long talk with him about his men's outfit for the expedition." Three subsequent visits to Elizabeth Bay House, as well as to the ship, were made on April 9th (with Reedy), April 15th, and May 7th. The plant-cases, charcoal, &c., were sent down and put on board on May 14th. In the meantime, Sir William Macarthur had generously sent down from Camden two liberal contributions to the commissariat—"April 23rd. Two tons of pumpkins, sent by Sir William Macarthur, from Camden, were put on board to-day." And "May 7th. A large load of things from Camden was put on board this morning—eight quarter-casks, and some octaves of Camden wine, three bags of beans, two ditto squashes, &c., &c. Sir William Macarthur went on board in the afternoon." "May 13th. E. S. Hill was on board to-day, and brought with him some heaps of Illustrated Papers. He has been most kind throughout, having lent me a chronometer, sextant, an artificial horizon, aneroid, &c., &c." "April 29th. W. S. Mort has offered me the use of an ice-making machine for the voyage, which I shall accept with thanks." "May 6th. Onslow went with Captain Edwards to see into the working of the ice-machine Mort has lent me."

Commodore and Mrs. Goodenough visited Elizabeth Bay House on February 28th—"The Commodore promises me charts, &c., of the New Guinea coast."—"March 2nd. I went to town early to make some enquiries connected with my New Guinea expedition. I called on Captain Hixon to ask about charts, &c. He is to write to Brisbane for the latest information."

Mr. Phelps presented some "Shrabsika cheese" for the voyage—"May 15th. Stephens brought me two large packages of gingerbread, made by Mrs. Stephens, for the voyage."

Before the departure of the *Chevert*, William Macleay was the recipient of many tokens of friendship and good will from a number of his friends. On April 3rd, Mr. J. J. Phelps, a squatter, and a Parliamentary friend, Member for Balranald, and the donor of specimens to the Macleay Collection, gave a fishing picnic, in William Macleay's honour. "Phelps gave a fishing party to-day. We

started in a snug steamer, about 10 a.m., and had a most enjoyable day. The party consisted of Phelps, Stackhouse, Alleyne with his boat's crew, Forster, Badham, E. S. Hill, Hay (Murray), Day (Albury), Raymond, Markey, Stephens, Masters and I. We had Charlie Hastie's boat, net, and crew, Tom Mulhall and his dredge, &c. I got a few things for preservation, the best, a species of *Pelor* or some such fish."

The Linnean Society of New South Wales gave a well-organized picnic on May 1st. "April 24th. Sir E. Deas Thomson, Captain Stackhouse, and Sandeman invited me to-day to a Picnic to be given by the Linnean Society to me, their President, previous to my departure for New Guinea." "May 1st. The picnic to me nominally by the Linnean Society came off to-day. There were three steamers, the *Leila*, Moriarty's steam-yacht, the *Agenoria* and the *Galatea*. The party numbered about sixty; and after fishing, &c., at 3 o'clock we sat down to a sumptuous banquet at Hunter's Bay, Middle Harbour. (Sir John) Robertson was in the Chair. I sat on his right and returned thanks. The only other toast was proposed by Badham in French, in honour of the French visitors, Simon, the Consul, and the Captain of the *Cher*. They both responded in French. We got home about 7 p.m., after a most pleasant and enjoyable day."

"May 3rd. I was entertained this evening at the Parliamentary Rooms at a sumptuous dinner given to me by a large number of Members of both Houses of Parliament. About sixty Members were present, Hay, the President of the Council, in the Chair. It was a splendid affair, and highly gratifying to me. The speeches, &c., went off very well."

"May 4th. I dined to-day with Dr. Roberts, at the Union Club. We had a first class dinner; present, Dalley, Sir E. Deas Thomson, Onslow, Watt, Knox, Dr. Boyd, Dr. Alleyne, and others."

"May 8th. I lunched at the Club, and afterwards revised the sheets of the Proceedings of the Linnean Society. I returned home to dress for a dinner given to me, at the Union Club, by the Treasurer and the Attorney-General. There were eighteen in all present, including Martin, with whom I shook hands. The dinner was excellent."

"May 16th. On Tuesday the Ministry are giving a large party on board a Hunter River steamer, to accompany me down the Harbour to see me off, so that honours are being showered upon me."

"April 12th. I had a letter to-day from Dr. Patterson asking me to allow myself to be nominated as a candidate for a vacancy in the Senate of the University. I intend to decline." Nevertheless, perhaps in recognition of the intended bequest of the Macleay Collection to the University, he was elected a Member of the Senate on May 15th; and he continued to act for the rest of his life.

William Macleay kept a separate Journal during the voyage. This was among the relics which Lady Macleay was good enough to hand over to me. The gist of it was published in *The Sydney Morning Herald* of October 11th, 1875; and is reprinted in the Introduction to the Macleay Memorial Volume (p. xxxii). Only a brief summary need be given here.

The objective of the first stage of the voyage was Somerset, Cape York, because this was a convenient place for watering the ship, and getting and sending mails from or to Sydney. The *Chevert* left Sydney on May 18th, and anchored off Shallow Bay, about a mile and a half beyond Somerset on June 18th. "Cape York, the most northern point of Australia lies about three miles west of us."

En route, the vessel found anchorages off (1) Percy Island, No. 2, 28th-29th May; (2) the west side of the largest of the Palm Island group, May 31st-June 3rd, where the steam-launch was unloaded; (3) Brooke Island, June 3rd-4th; (4) North Barnard Islands, June 4th-5th; (5) Fitzroy Island, June 5th-6th; (6) Low Wooded Isle, June 6th-7th; (7) Turtle Reef (covered entirely at high tide), June 7th-8th; (8) No. 4 Howick Group, June 8th-9th (no landing here); (9) Flinders Island, June 9th-10th (no landing); steam-launch visits Barrow Island; (10) 10 miles south-east of Cape Sidmouth, June 10th-11th (no landing); (11) Six miles south of the Piper Islands, June 11th-12th (no landing); (12) Cape Grenville, June 12th-17th and watering ship from 14th-16th; (13) Boyston Cay, June 17th-18th (no landing); (14) Somerset, June 18th-26th.

As daylight was necessary for navigation, the stoppages Nos. 9, 10, 11, and 13 were for the night only, and there was no opportunity for landing. When this was the case, line-fishing at night was carried out, and the dredge with swabs put down, not without success. Everywhere else, though sometimes the weather was unfavourable, systematic collecting was carried out.

Before reaching the Percy Islands, many sea-birds were seen, and specimens of *Diomedea melanophrys*, *Pterodroma macroptera*, *Fregetta melanogaster*, and *Oceanites oceanica* were obtained. The day after leaving Sydney, a shark, measuring 10 feet 9 inches, was caught. This also yielded examples of *Lernea* sp.

"On Percy Island, a crow, a curlew, and a small flycatcher were all the birds got. But last night's fishing made up for much lost time. By the seine, drawn four times on the little beach at our anchorage we got some of the finest garfish I ever saw; indeed so enormously superior in size were they to anything even seen in Sydney, that Mr. Masters put a few into the tank, under the impression that they could not be of the same species. The Whiting, though few in number, were also very fine. There was a pike or two-jawed garfish of enormous size. The rest of the fishes were chiefly large examples of Labridae and of brilliant Carangidae, nearly all new to me. But the line-fishing over the stern of the ship up till 3 o'clock this morning was still more productive. Many species of fine large schnapper-like members of the Sparidae, all new to me, a very fine Siluroid fish, and several specimens of a shark, apparently of the genus *Loxodon*, full-grown at a length of 20 inches, the young free in the uterus. The dredge was out over the stern during the night, and, in the morning, with the swabs, presented a fair return, one or two good shells, including a new species of *Murex*, Crustacea, a number of Polyzoa, Polypifera, Echinoderms, Foraminifera, &c. I have tried to preserve some Gorgonias in a solution of chromic acid, as an experiment, at Captain Onslow's request. The catch was most miserable in the Insect-tribe. Petterd looked solely after them, and got nothing worth notice, excepting about twenty spiders, which were good. Danaids and *Eurycus* were abundant, and were seen far out at sea."

Two not altogether unprofitable days, notwithstanding squally, showery weather were spent at the Palm Islands. "June 1st. We divided ourselves, as follows. Masters, Spalding, and Dr. James, with a native guide started inland. Reedy, Dingwall, and Petterd also went inland in a different direction. Onslow, Cashman, the Second Mate and Davis, A.B., went along the coast to the south; while Brazier and I took the reefs to the north. The total captures for the day comprised two wallabies of a new species, twenty-five birds, mostly of the extreme northern species, two of these shot by me, new to the collection—the Black Oyster-catcher, and the Northern Gull—and one shot by Masters, a new species of

Zosterops. A number of good shells, crustaceans, echinoderms, &c., were got upon the reef, and a new *Helix* on the land. Very few insects were taken, but enough were seen to show a great wealth of Diurnal Lepidoptera—*Papilio*, *Ulysses*, *Cethosia*, *Ornithoptera*, &c. Reedy's botanical collection was bulky and satisfactory, but nothing new, he believes, which was scarcely to be expected. On our return to the ship, we found great progress had been made in the arrangements for putting the steam-launch overboard, and at 3 p.m. the work was successfully accomplished. We are to stay here to-morrow for various reasons, and hope to have another successful day's collecting. The beaches, however, are too shallow, and the old coral extends too far out, to enable us to use the seine with safety." "June 2nd, the day has been squally, with frequent showers, but bad though it was, we could not afford to lose it. . . We got very few birds to-day; the reef-birds, which we mostly wanted, were so shy and wild, that there was no getting a shot at them. Of small fishes, crustaceans, and other marine forms, however, the reef furnished us with a rich harvest." Some Blacks, visitors from Cleveland Bay, were met with.

The weather was stormy while the ship was anchored off Brooke Island, June 3rd-4th, but a party landed, and made rather a good collection, including birds (*Sula fiber*, *Haliaetus leucosternum*, *Megapodius tumulus*, a goatsucker, etc.), crustacea, echinoderms, and a few land shells.

At the North Barnard Isles, June 4th-5th, the weather improved. A landing-party did well on the reef at low water; and Masters got a male and two females of the rare *Ptilotis Victoriae*.

Fitzroy Island, like some of the others visited, was rough and precipitous, and almost impenetrable from the density of the brush and the length of the grass. Very little was collected except some desirable birds, though all the collectors were active.

The next stoppage, June 6th-7th, "a mangrove sandbank surrounded by a large coral-reef, marked on the chart "Low wooded Isle", distant 45 miles from our last anchorage", provided better opportunities. "June 6th. After dinner, we all went ashore to examine the reef, Masters, Spalding, and Dr. James with their guns, and the others with bags, baskets and buckets. It was the first regular reef I had been on; and, though I did not see any of the great beauty and variety of colouring said to be characteristic of the outer Barrier Reef, I still saw enough to impress me deeply with the wonderful variety of life with which it abounded. The whole reef was literally teeming with life—fishes, crustaceans, echinoderms, coral-polyps, etc., in countless numbers. Of the first of these, we caught numbers in the shallow waters on the reef, a sport in which all hands joined. A good many new and beautiful species were taken, including three species of sharks, one, spotted, a great beauty. Bêche-de-mer of many different species was also abundant. We saw a great many examples of *Tridacna*, *Hippopus*, and other large shells, which though very striking, are sufficiently common; but Brazier has got some good things among the smaller species. The shooting-party got specimens of the white reef-heron, some gulls, and a tern. We returned to the ship at sunset, loaded with specimens and trophies."

A party landed on a small sandbank, covered at high tide, off Turtle Reef, on June 7th, but got little except two specimens of a Tern new to the collection.

The ship arrived late in the evening, and left again early the next morning, at the next four anchorages—No. 4 Howick Group, Flinders Island, ten miles south-east of Cape Sidmouth, and six miles south of the Piper Islands. But the

steam-launch visited Barrow Island on 9th June, the wind being light, and afterwards overtook the ship again. Two birds new to the collection, the Caspian Tern and *Ptilotis versicolor*, some lizards, land-shells and a few insects were procured. The night-lines off No. 4 Howick Group brought up a considerable catch of fishes—"mostly small, but of six species quite new to me". On June 10th, the breeze was so light that the dredge was put overboard, and brought up a satisfactory lot of mollusca, crustacea, &c. Fishing over the stern on the night of the same day was carried out with success, as also on the following night.

Five days' stay off Cape Grenville, June 12th-17th, were utilized to the full, notwithstanding a gale with showers on two days, in watering the ship, in dredging and seining, in reef- and shore-collecting, and in visiting both the mainland and some of the islets for land-animals and plants. The mail-steamer for Sydney, two days early, unexpectedly hove in sight on June 14th. The launch happened to have steam up; and the Captain of the S.S. *Normanby* kindly stopped, and took charge of the *Chevert* mail, together with some casks and packages of plants collected by Reedy, for Sir William Macarthur. On the same day some intricate navigation was carried out by Captain Edwards, with great skill and judgment. "In order to get into the deep and well-sheltered bay, where we now lie, it was necessary, in approaching it from the south, to pass over a rocky shoal—a sort of continuation under water of the Home Islands and the mainland. This was done with pluck and caution. All sails, but the topsails, were taken in; and the launch was kept constantly sounding 400 yards ahead. At one time, we could not have had above two feet of water to spare. Watering the ship occupied three days. Casks were filled at the source of supply, rolled along the beach at low tide, and taken off to the ship in boats. Five loads of the big boat, about 1,000 gallons, were taken on board on June 14th. These were supplemented on the next two days, and the watering was completed on the 16th. A party of twenty Blacks rendered most efficient aid in the watering-operations. The Captain speaks highly of the assistance rendered by the Blacks. They seem to prefer hard work for biscuit, etc., to their very easy way of supplying themselves with their ordinary necessaries of life. I dare say it is simply the love of change and not love of labour which moves them. Altogether they are a most excellent lot of niggers, affable and lively in the extreme; and they exhibit a desire to make themselves useful and agreeable. They have found out my interest in animals of all kinds, and have consequently all become collectors. To-day they brought me fishes, shells, &c., and a species of snake new to me." Others came off to the ship in canoes, as soon as she anchored, offering fishes which they had speared.

Mr. Brazier systematically carried out very successful dredging. "June 15th. Brazier got very few shells, but was most successful in Echinoderms and Polypifera, including one *Comatula* of large size, the most wonderful example I have seen." "June 15th. Brazier got many fine Echinoderms and Mollusca—altogether the most successful day with the dredge we have had."

Important additions to the bird-collection, some new and some rare, were made by Masters and Spalding. Also to the collections of reptiles and land-shells. The seine was hauled on the beaches and yielded many specimens of fishes, as also did line-fishing. "June 16th. At 12 noon, I went to a reef on the nearest island, with Masters and Brazier. We were subsequently joined by Onslow and Spalding. We got a number of good things on the reef—fishes, crustaceans, echinoderms, &c. Masters went after birds, and succeeded in getting about half a dozen speci-

mens. Reedy and Dingwall went ashore early, to collect plants on the mainland." The botanical collectors throughout were no less enterprising than their zoological colleagues. The additions to the collection of marine invertebrates were very numerous. But the search for insects yielded rather poor results. Geological specimens, here as elsewhere, were accumulated.

There was no opportunity of landing at Boyston Cay. Seven and a half days' stay was made at Mud Bay, about a mile and a half beyond Somerset. It was not easy to reach the settlement, even with the launch, as there was a strong head trade-wind blowing through the funnel between Albany Island and the mainland, and the current with the flood-tide was quite five knots an hour. Nevertheless visits were made to the settlement every day, the first on the morning of June 19th. "After breakfast we got the launch alongside under steam, and with the dingy towing behind, the Captain, Onslow, Masters, Brazier, Reedy, and myself started for the settlement. We were met at the landing-place by Mr. Aplin, the Government Resident, who expressed himself as very glad to see us; and asked us to accompany him to his residence, a roomy, comfortable cottage situated on an eminence commanding a beautiful view of the harbour and anchorage of Somerset. We met, at his house, Mr. Beddome, the late Resident, who has now a pearl-shelling establishment on a neighbouring island; Broadbent, a bird-collector, had lately left, also Mr. D'Albertis, an Italian naturalist, who had gone to some part of New Guinea. Mr. Macfarlane, the head of the London Mission, was also absent, having started a week ago, in the *Ellangowan* for Redscar Bay". An unusual prolongation of the wet season had caused much sickness. "The natives particularly have suffered. Mr. Aplin tells me that, within the last few weeks, the local tribe, a numerous one, has nearly died out, bodies lying unburied in some cases. Amongst the few remaining survivors, whom I saw about the settlement, the majority were ill and attenuated. Diarrhoea seems to be the disease they suffer from. I will get Dr. James to see some of them, and endeavour to ascertain the cause of such extraordinary mortality."

In the afternoon, a party went shooting and seining in Shallow Bay. "Masters got some small birds, which he thinks to be new. The fishing was a great success. We hauled the seine three times, and got a great many bushels of fine fish, large quantities of a fine Mullet different from that of Port Jackson, a species of perch resembling the Black Bream, a number of whiting, several kinds of *Caranx*-like fish, and several other species; specimens of all of them were kept. Altogether a good day for most things, but still no insects worth mentioning."

On the following day, William Macleay remained on board to receive visitors, Mr. and Mrs. Aplin, and Mr. Beddome, who came to dinner. Masters and Dr. James got a lot of small birds, some desirable specimens among them.

On June 21st, a party again visited Somerset. Under the guidance of a native policeman kindly sent by Mr. Aplin, Masters and Dr. James went out for birds, and brought back a number of small ones and one fine male Rifle-bird. "It seems that this is a bad time of the year for birds at Cape York, as they go north in the winter." Mr. Brazier with Mr. Beddome collected land-shells. Reedy and Dingwall, with a native guide, went botanising. Captain and Mrs. Were visited the ship to dine. "He has been a good deal on the New Guinea coast, and gave us valuable information." "I went out in the morning with the fishing-boat, and hauled the seine in Shallow Bay, in three places, with

great success, getting many bushels of fine Mullet, Whiting, Garfishes, &c., though but few for the specimen-tank." "Brazier got some good land-shells, one new. Reedy, I believe, also had some success." A few tons of ballast were taken on board.

June 22nd. After Masters and Brazier had packed away in a hogshead all the fish sufficiently hard to be safe (about 250), together with other specimens, in spirit, to be stowed away below, "we all went away with the launch, dinghy, and fishing-boat to Evans Bay. Masters and Spalding got some good birds, and Reedy some plants; but there was too much surface for the net or dredge. However, we called in at Nicea Bay on our return, and got lots of fine fish, Mullet, Whiting and spotted Garfish, &c."

"June 23rd. To-day, the Captain, Onslow, the Doctor and Brazier have gone to the Settlement. Masters is packing away his bird-skins; Spalding and Petterd are skinning the birds got yesterday; and Brazier is away with Mr. Beddome. After dinner, the rest of us went to Shallow Bay. We had three hauls of the seine, and got some good fish, but nothing like the quantity on previous occasions. Masters and Spalding shot a few birds; and Petterd caught a number of a *Cicindela*, like *C. upsilon*. They also set four traps, baited with cheese for small mammals. The Doctor shot a *Cuscus*, and a lot of birds; and Brazier got no end of land-shells on Albany Island, and some from other islands, presented by Mr. Beddome."

June 24th. The settlement was visited in the morning, and Captains Were and Hastings visited the ship in the afternoon. Brazier was out for the day again with Mr. Beddome, and brought back, *inter alia*, four aboriginal skulls. Masters being unwell, did not leave the ship. Spalding and Petterd went to bring off the traps, which contained two specimens of a species of *Hapalotis*.

The mail-steamer from Sydney arrived early on June 25th. The mail was received the same day; letters were replied to, and a mail prepared for the next steamer for Sydney, due in about a fortnight. "Sir William Macarthur sent us by the mail-steamer, a number of cases of oranges, and two large casks of bacon, &c. These we could not get on Friday, and I could not lose another day waiting for them. The steamer-arrangements for the delivery of cargo here are extremely bad."

The *Chevert* was under weigh at 9 a.m. on June 26th, after waiting for the launch to return from Albany Island with Tonga Joe, his wife, and family, who were to be passengers to Warrior Island, their home. "The Captain has secured the services of 'Tongatabu Joe' as pilot and interpreter to introduce us to the people of Warrior Island and New Guinea. He has been a sailor in the English navy, has wandered over many seas, and for the last ten years, has been among the pearl-shellers. We are to take his wife and family with us to Warrior Island, his present home; and after leaving them there, he says he is ready to go anywhere with us." When the passengers had embarked, "we had a good and favourable wind, and soon lost sight of the shores of Australia".

The objective of the second stage of the voyage was the western side of the Gulf of Papua, as mentioned by William Macleay, in his speech at a banquet tendered to him on the eve of his departure.—"I intend in the first place, to visit the large delta on the western side of the Gulf of Papua, which consists either of numerous mouths of one river, or the mouths of numerous rivers."

The choice of this objective was primarily suggested by Chapter xi in Volume i of Jukes' "Narrative of the Surveying Voyage of H.M.S. 'Fly', com-

manded by Captain F. P. Blackwood, R.N., in Torres Strait, New Guinea", &c. (2 vols., 1847), which, on February 28th, William Macleay notes that he had been reading.

The *Chevert* left Mud Bay, off Somerset, about 9 a.m. on June 26th, "Not having time to make Warrior Island before dark, we anchored, about 3 p.m., under the lee of Sue Island, the middle one of three, small, low islands, surrounded by reefs, named in the aggregate the 'Three Sisters', and respectively, Poll, Sue, and Bet". A collecting party landed. "Masters got some good birds, Spalding a snake, every one got something", including a number of the eggs of the Hawksbill Turtle. Two new species of fish were caught from the stern of the ship.

An early start for Warrior Island was made on June 27th, but the wind fell so light that an anchorage, three miles from the shore, in rough water was not reached until 2 p.m. The Captain, and a party, including Joe the pilot, landed. "Two of the natives came off in the boat, at Joe's invitation, to accompany us to New Guinea, and introduce us to their friends". A few small birds, a snake, some lizards, and insects were obtained.

"June 28th. We got away early, and proceeded in a northerly direction, with a man in the chains, heaving the lead, and two men on the fore top-gallant yard. Our average depths were from 5 to 15 fathoms. In the afternoon the sky became clouded, and we ran into a 2½ fathom patch, along which the ship scraped for a short distance. As soon as we got into deep water, we anchored for the night. Our position was about 10 miles south of the mainland of New Guinea, in a kind of bight formed by the Warrior Reef on the east, and Saibai Island on the west. The mainland was distinctly visible in an unbroken line almost from north-east to west. . . . There was rather a heavy sea, which caused the steam-launch (which was in tow) to knock about and against the ship; but, nothwithstanding, on first anchoring, and before the current became too strong, a few fish were caught, including a very large *Gristes*-like form. Some butterflies flew on board."

"June 29th. We got away about 9 a.m., the morning being occupied in taking soundings by the boats, with the launch ahead, also taking soundings. We advanced about four miles towards the mainland about Katau, and then got into such an entanglement of two-fathom shoals, that we had to drop anchor. We afterwards weighed anchor to secure a deeper anchorage. The launch is now out searching for a passage for us for to-morrow." A few fish were taken over the stern, including a very large toad-fish. The swabs, put over the stern the previous night, were unfortunately lost.

"June 30th. It rained heavily until mid-day, and all hands took to washing clothes. After dinner it was moderately fine, and the ship was moved about a mile nearer her destination, past a reef which had been buoyed the night before. Onslow then went out in the fishing-boat to look for a passage onwards to the west of north, but was unsuccessful. The Captain and I went in the launch in a direction rather east of north, and found clear water up to within two miles of the Katau River. We have tried fishing, dredging, and tow-netting here, but with very little success. The average depth is from five to six fathoms with a muddy bottom."

July 1st was beautifully fine, but the expectation of reaching an anchorage about two miles off the village of Mokatta, at the mouth of the Katau River, was not realized until the following day. In approaching the shore under easy

sail, and with a favourable current, it was found that one of the buoys had drifted; and an unwise order to drop anchor, at a critical moment, led to its irrecoverable loss, together with over twenty fathoms of chain-cable. The vessel thereupon anchored for the night.

"July 2nd. We were engaged for some hours in vainly looking for the lost cable and anchor, and in re-doing the work of the previous day—buoying the channel. Just before dinner we ran in about two miles towards the mouth of the Katau. After dinner, a further distance of a mile, or a mile and a half, was buoyed; and, before dark, we got to our present anchorage, about two miles from the mouth of the Katau, and the native town of Mokatta. We shall probably be here now for some time, the difficulty of getting to the place—constant, shallow reefs for the last ten or twelve miles—making it necessary to utilize our position as much as possible."

The visit to the Katau lasted from July 2nd to the 12th, two days later than was intended, on account of a head wind, and the illness of the Captain. The efforts of Tonga Joe and the two natives brought from Warrior Island, to promote friendly relations between the natives and the visitors were effectual. Collecting-parties landed every day up to and including July 9th. About twenty natives, including Maino, the headman of the village, and his son, came off to the ship in two canoes, on July 3rd. After breakfast, all who could be spared went ashore in the surf- and fishing-boats. The engineer, Mr. Hargraves, had been overworked for some time, and needed a rest. The natives were most friendly. "A regular trade in cocoanuts, bananas, taro, yams and sweet potatoes was conducted by Tonga Joe, who seemed quite *au fait* at that sort of thing. As soon as the boys of the village were made acquainted with the objects of our visit, they displayed wonderful activity in collecting grass-hoppers and other common things for us, which I felt bound to accept, in order not to damp their enthusiasm." The village and its surroundings were inspected. "The village consists of seven long houses, built on poles, 6 feet above the ground, with open gable-ends, and thatched roofs, exactly as described by Jukes in his 'Narrative of the Voyage of H.M.S. *Fly*'. They probably house 60 or 70 people each, bringing the total population to nearly 500. Two of the houses are parallel to the beach, the rest end on. They are scarcely above high-water mark; and behind them the ground is a stinking marsh. All round the houses are stinking remains of animals, human skulls, faeces, &c. . . . We made an attempt to get a little inland, by a path leading from the village; but, after going through a great deal of filthy morass, we found the path terminated in a clearing of a few acres planted with bananas, taro, and yams. The cocoanut-palms are numerous along the sea-border, but do not seem able to penetrate into the dense jungle behind. The Captain, Onslow, and I returned to the ship at one o'clock, leaving Tonga Joe to show Masters, Brazier, Spalding, Reedy, Dingwall, and Dr. James where the shooting was to be got." They returned to the ship about sunset, bringing a few gorgeous birds, land-shells and insects. "Nothing can exceed the richness and density of the vegetation of the coast at this point, but we have been unable as yet to discover the slightest variation in the one perfect level."

"July 4th. A large party of us, eighteen in all, started in the launch with the surf-boat in tow, to go up the Katau River. We took on board, at the village, Maino and Owta, the chiefs of the respective villages, besides Joe and our Warrior Island friends." After making good progress for eight or nine

miles, further advance was completely blocked by a great tree, which had fallen across the river, at this point about 30 yards wide, though at the mouth much wider. "The vegetation throughout was wonderfully rich and dense; and birds of strange cries and magnificent plumage were abundant, though we succeeded in getting only a very few. We frequently saw crocodiles, but none exceeding six feet, slip off the banks into the water."

From July 5th to 8th the weather was stormy, with rain. A party landed each day, but without much in the way of results for the first two days. But on July 7th, notwithstanding unfavourable weather, "the launch and surf-boat went to the landing and returned about 1.30 p.m., with half a dozen natives, to stop for the night; and a boat-load of bananas, cocoanuts, and a miscellaneous collection of arms, implements, ornaments, snakes, shells, crabs, insects, &c., collected by the natives. This is the best day, as far as collecting is concerned, we have had; and much more is promised by the natives of all the villages." A large party went again on July 8th, and, though not able to do much themselves, brought back "a number of good things, such as snakes and lizards, from the natives".

On Friday, July 9th, a second ascent of the river was attempted, but the fallen tree proved an insuperable obstacle to navigation. Otherwise the party had a most pleasant day. The bush natives up the river everywhere received the visitors well. The chief or head-man of one village, with twenty men loaded with cocoanuts and bananas entirely as a present, met them; and in all directions there were manifestations of friendship. "Knowing also of our wish for all sorts of living things, they had brought specimens of snakes, lizards, insects, as well as ornaments, &c., so that we made a really good haul this day."

A friendly farewell visit to the village was made on July 10th, and on the same day, the Captain received instructions to get ready for departing. The morning was spent in taking soundings, with the departure in view. The illness of the Captain and a strong head wind delayed any progress on the 11th and 12th. On July 13th a move was made, but, in consequence of the intricate navigation, and the time spent in sounding and finding a passage, it was not until July 16th that the way was clear. The ship anchored about five miles north-west of Warrior Island on the evening of the 17th; but moved a few miles south next day, in order to shelter under the lee of Dungeness Island. The launch took Tonga Joe and the two natives to their home at Warrior Island, and brought back some weapons and shells. Parties landed three times on Dungeness Island, on July 19th and 20th and brought back birds (a species of *Megapodius*, the frigate-bird, a fine large kingfisher, and others), lizards, fishes, mollusca, &c.

The next objective was Darnley Island, which was not reached until July 30th. "July 20th. We weighed anchor after dinner, and sailed twelve miles to our present anchorage, under the lee of Long Island. It blew hard all day, as, in fact, it has for the last fortnight. The strength of the gale has prevented our moving for the last two days." A party went ashore on July 21st, and obtained a number of birds, fishes, &c.; and again on 22nd, with the nets, to do as much as possible.

"July 23rd. We left our anchorage at Long Island at sunrise this morning, and after a rough run of some hours anchored here, under the lee of Bet Island. The wind was not only strong but unfavourable; and the frequent tacks we had to make were not without risk to the steam-launch, which we had to tow, as her boiler is out of repair. We made, in a straight line, only about six or seven

miles. There was great collecting on Bet Island this afternoon, plenty of Torres Straits Pigeons and flying-foxes, &c., but no fish, and only a few shells."

"July 25th. We weighed anchor early yesterday morning and sailed for an hour or two in the direction of Cocoanut Island, but the violence of the wind forced us to run back here (Bet Island) for shelter, where we are still lying, wind-bound. Yesterday afternoon we landed, and shot a large number of Torres Straits Pigeons, enough to feed all hands. It is a most delicious bird. The attraction for them here at this season is the fruit called the 'date', which is very abundant. As the season advances, they proceed southwards to the Australian coast. Flying-foxes are also very abundant, drawn hither, no doubt, by the abundance of 'dates'."

"On the 26th, the wind being still unfavourable and blowing a gale, we ran down to Sue Island, and anchored in a sheltered position. In the afternoon, Masters and I went ashore; and shot a few pigeons, and a number of other birds, including six species of small waders. On the 27th, we made an attempt to get eastward, between the reefs of Bet and Sue; but, after many tacks in a heavy sea, we had to run back to the lee of Sue Island. Again, in the afternoon, a party went ashore, and some good birds were got. I had the dredge dropped a few fathoms from the ship. When pulled on board, it was quite full of yearling pearl-shells, but there were no full-grown ones. On the 28th, at 10 a.m., we left Sue Island; and, after much difficulty and tacking, we reached our present anchorage, off Cocoanut Island, at 4 p.m. It is a low island, resembling the Sisters, but with a few cocoanut trees. . . On 28th, we made York Islands, after a rapid run of 3½ hours, the wind blowing almost a gale. After making the Islands, we had to put about two or three times to find a good anchorage, much to the detriment of the launch; and, after all, had to drop anchor in an exposed position three miles from the shore. On the 30th, the wind was a little more moderate, and we weighed anchor about 11 a.m. We got upon a reef, and bumped once or twice near Tobin's Cay, and had to put about for a time; but we eventually reached this place (Darnley Island) in safety about 3 p.m., and got a smooth anchorage close inshore, at Treacherous Bay. We had time to go ashore, to visit the watering-place, and to select a place for beaching the launch."

The ship remained at her anchorage from July 30th-August 13th. The launch was beached next morning, had her bottom cleaned and tarred, and was refloated. Watering the ship occupied four days, August 2nd-5th, about 1,200 gallons being taken on board. Parties landed every day to collect. "July 31st. A few insects were got, but no birds to speak of. I anticipate doing more in the way of fish and shells here than anything else. . . . August 1st. I went ashore with Brazier to search the shore at lower water. We got a good many shells, &c. In the evening I purchased from natives a large snake, and a mummied human head." The natives were most friendly and hospitable, and the missionary (a Lifu man) visited us.

"August 2nd. All my people have been out; and, upon the whole, the collecting has been good. The chief things were got on the shore at low water. One of the Rotumahan sailors died on August 4th, and was buried in the village cemetery. August 6th. I have succeeded in getting several mummied heads; and the first mate has gone round in the boat to the village to get me a complete mummy which has been promised him. The launch is now refitted and at work again. For the last two days she has been employed in dredging; and with great success. Indeed for shells and marine animals generally, this has proved a

very good place. Fish seem to be plentiful, but we have not got many. The sucking-fish are numerous about the bow of the ship. Birds are few and not of much account. Insects are very few, but the diurnal Lepidoptera are fine."

"August 11th. We are still at Darnley Island, but intend to leave to-morrow morning for Bramble Cay, and thence to the east side of the Gulf of Papua. The *Ellangowan*, missionary steamer, came in from Cape York on the 7th, and anchored near us. The Rev. Mr. Macfarlane preached on board this ship on Sunday evening. He is accompanied by his wife, and Mr. Stone, a traveller. The *Ellangowan* left this morning on her return to Cape York. . . . Mr. Williams got the mummy on Friday, and it is now securely packed away with sundry heads, &c. I have kept the dredge going almost constantly, and we have been most successful. With other things but little has been done. I am going to leave the steam-launch here, in charge of the Lifu missionary, until I return from New Guinea, as I find that the heavy sea in the Gulf of Papua would make towing dangerous; and to hoist her on board again, would be too great an undertaking."

"August 13th. On the 11th, about midnight we were joined by the Government cutter *Lizzie Jardine*, very kindly and considerately sent from Cape York by Mr. Aplin, with our mails, &c., as soon as he heard of our being at Darnley Island. Besides letters and papers, she brought us potatoes and bacon from Sir William Macarthur; and also an additional botanist, named Knight. In order to answer our letters, we remained at Darnley Island all day yesterday. This morning we weighed anchor at sunrise, and in a wonderfully short time ran the thirty miles to this place, Bramble Cay, where we are now anchored. I went ashore with Masters and Petterd, before the others, in hope of being able to identify the owners of the various birds' eggs we expected to find; but, though birds and their young were very numerous, there were scarcely any eggs. *Sula fiber*, the Crested Tern, the Sooty Tern, and *Anous leucocapillus* were very numerous, besides *Sula cyanops*, the Man-of-war Bird, and sea-gulls. I also saw one Rail, and Masters saw some Whinbrel. A few fishes and shells were got on the reefs. Skeletons of turtles were lying about. A party are on shore to-night in search of Turtles."

"August 18th. We left Bramble Cay on the morning of the 14th for Hall's Sound, New Guinea. It blew hard from the south-east; and in order to get well to windward, the Captain ran south as far as Nepean Island, and anchored for the night. Next day we were occupied until 4 p.m., in getting to Anchor Cay, whence we started upon our voyage across the open Gulf. We had a rough night of it, and next day, 16th, at noon, we were only 30 miles from Cape Possession, when it fell calm; and ever since, until 3 p.m. to-day, we have been tossing and rolling in a heavy sea, without progress, and under a burning sun. We are now (at 8 p.m.) anchored in Hall's Sound, at the north-west point of Yule Island. . . . The place promises well for insects especially, so that we may make some stay here. Mr. D'Albertis has his house or hut on the side of the hill, opposite the anchorage." A party landed on the island in the morning. The natives were at first shy, "but when they found that we were disposed to make presents of coloured prints, &c., we were quickly surrounded by men and women, all anxious to receive, but not to give anything." Some of them were induced to visit the ship. . . . Of mammals at this place, we have got a large species of flying-fox. Of birds, a parrot, a swallow (new), a sunbird, a cuckoo-pheasant, a *Megapodius*, and *Calornis metallica*, which is breeding in immense numbers in a gigantic tree near the village. Of reptiles, I have scarcely

any. Fishes and marine things generally, I am going to try for after dinner. Brazier has got six or eight new species of land-shells, some very fine. Lepidoptera are numerous and handsome. Coleoptera, chiefly Longicorns, are tolerably abundant. Flies, a species of *Bibio*, are flying about the ship in thousands. The heat is intense."

"August 28th. We have now been here ten days, and, upon the whole, have had fair success with our collections. The natives were very shy of us for some days; but, of late, the ship has been visited daily by many canoes, as many as fifteen in one day. They are anxious to get knives, tomahawks, looking-glasses, and showy prints, but have little or nothing to give in exchange, except cocoanuts and bananas, which they value too highly. I have got some of their stone-adzes, spears, and a few bags of strong net, very well made. They manufacture also strong nets for fish, and for catching kangaroos, &c. They use pottery, but I have not seen any manufactory of it. Mr. D'Albertis returned home on the 22nd, and gave us a call next morning."

"On Tuesday (24th) a large party of us went across to the mainland opposite our anchorage, where some hills come close to the water. A number of birds were obtained, mostly new to us, and a few insects. We saw tracks of kangaroos, but nothing else worth mentioning, except a gigantic snake 13 feet 6 inches long. On the following morning, at daylight, we started in two boats to go up a river named the Ethel, on the east side of the sound. We had some difficulty in getting over a shallow bar at the mouth, but thereafter there was plenty of water. We got about ten or twelve miles up the river, when we were stopped by timber. We camped for the night at a spot where the river abutted on one side on a hill, near a deserted banana plantation; and passed a most miserable night, some of us in the boats, and the others on land. The mosquitoes were in myriads, and there was not a breath of wind. We returned to the ship about 4 p.m., on the following day, very tired. We brought back about thirty birds, mostly new to us, a small opossum, and a few insects. We found, as seems to be the case everywhere here, this country to be most difficult to penetrate, along the river a dense mangrove-swamp, and where it is possible to get an opening to the country behind, the prickly vines bar progress."

"August 27th. We again went over to the mainland opposite to us, and got a number of good birds, but very little else. August 28. My men are employed preserving the birds got yesterday, about thirty-five in number." After some remarks on the geology, the Journal concludes with the sentences—"Once or twice since we have been here we have been treated to a view of the main Mountain range standing-up like a huge wall far into the sky. Our view this morning took in the whole range from Mt. Yule to Mt. Owen Stanley, the finest sight I ever saw."

After this, there are no more entries.

From the article contributed to the *Sydney Morning Herald*, it appears that the *Chevert* remained at the anchorage off Yule Island until September 2nd. "On leaving Hall Sound, it was my intention to visit Redscar Bay, about 24 miles to the east-south-east, as there were still three weeks to run of the time which I had fixed upon for my return to Cape York. But on finding the wind unfavourable, and that we might be a day or two doing what I had hoped to do in three hours, I gave instructions for an immediate return to Darnley Island, to pick up the steam launch *en route* to Cape York. On Wednesday, the

8th September, the *Chevert* dropped her anchor in her old anchorage near Somerset, and my expedition to New Guinea came to a close."

To save time, William Macleay and G. Masters left the *Chevert* at Somerset, and returned to Sydney by the mail-steamer, arriving on October 9th. The *Chevert* then resumed the return-voyage, and anchored in Port Jackson about a month later, after an absence of about six months, in time to enable Mr. Brazier to exhibit seven rare or new mollusca from Darnley Island and Hall's Sound, at the monthly meeting of the Linnean Society on 29th November.

The Journal was kept regularly up to May 17th, the day before the departure of the *Chevert*. "I have almost completed everything for a start to-morrow. The steam-launch was got on board this evening, not without difficulty. It has been a very busy day on board, and a great deal is left to be done to-morrow. We start nominally at 10 o'clock, but as the Ministerial Picnic party will probably lunch at 1 p.m., it is not likely that we can get outside the Heads till 2 p.m.; in that case the ship will have from 12 to 1 p.m., to get ready. . . . This is probably the last entry I shall make in this book for many months, as when I do keep a diary at sea, it will be on a larger scale."

The Journal was kept for two days only, October 11th and 12th, after William Macleay's return. These entries chiefly relate to private matters, but incidentally note his return by the mail-steamer on 9th, the friends who had called, the publication "of my account of the voyage in this morning's *Herald*", the parcels of books from a bookseller in London, and of exchanges from Mr. Edwards and Dr. Dohrn, and a large box of bird-skins from Gruber in San Francisco, which had been accumulating during his absence. "October 12th. Masters and I marked off Gruber's birds, and put them aside. There are some valuable birds from the Arctic regions of the Pacific, and from Arizona, mixed with some common enough things. Dohrn's boxes have some good things, but I have not gone closely into this yet."

After this, in consequence of pressure of work and engagements, the Journal was discontinued until January 26th, 1876. Pending the return of the *Chevert*, expected in about a month, routine work, and arrears were attended to. An entry at the beginning of the volume for 1876, irrespective of the entry for the day in its proper place, summarizes what happened in the intervals between October 13th, 1875, and the date mentioned—"January 26th, 1876. Since my return from New Guinea in October last, I have ceased to keep a diary. I am now, on January 26th, 1876, about to commence again. But before doing so, I wish to make some notes on what I have done, or what has happened during the above-mentioned period. My Museum has been much added to. The collections made during the voyage of the *Chevert* have been now almost all removed from the original packages. The mammals and birds have been mostly named and catalogued. The insects have been carefully laid out. The reptiles and fishes have been bottled, or, when too large, packed away in tanks. The Crustacea have been dried, and so have the Echinodermata. To some extent, myriads of small things have been bottled; and the Shells have been catalogued. To get through all this work, I have had, and still have, three assistants, Messrs. Masters, Brazier, and Spalding, fully employed. I have had besides large collections of birds, &c., from other places, 800 birds from London, a number from San Francisco, and a good collection from Fiji, besides various purchases and donations. The collection is so extensive, that I find I have no room in the house, even with the library, for the whole of it. I have, therefore, commenced a building

on one of my leased allotments of land in the garden, to be used as a Museum. It is to be 115 feet × 36 × 9, constructed chiefly of iron. The cost is to be £1,080."

The scientific visitors during the period for which the Journal was kept, included:

Dr. H. G. Alleyne, two visits, one with W. J. Stephens, to see a remarkable specimen of a Kingfish; and, accompanied by Captain Stackhouse, to see the collection—Mr. H. H. Burton Bradley "spent the forenoon with me, looking-up and talking about Spiders, &c."—Rev. G. Brown, "a missionary from Samoa, who is now going to form a mission at New Ireland, a new field for Natural History as well as for souls; and who wishes to collect", came to luncheon on March 5th. "I gave him a few hints about collecting at New Ireland, and how to do it."—Mr. Davis, a Parliamentary friend, and frequent visitor to Elizabeth Bay House, who had just returned from a visit to New Zealand, "brought me three perfect specimens of *Sphaeria Robertsii*."—Baron A. von Hugel "called on me to-day. I was not at home. I must return his call to-morrow".—The Rev. R. L. King and his brother, the Hon. P. G. King, who wished to inspect the *Chevert*—Sir William Macarthur, several visits, in connection with the fitting-out of the *Chevert*—Dr. Cox, numerous visits, bringing donations, or to talk over the prospective voyage to New Guinea—E. P. Ramsay, to see the mounted Sunfish, and "our plan of doing it"—Captain Stackhouse accompanied Dr. Alleyne, to see the collection, and stayed to lunch—W. J. Stephens, numerous visits, during his vacation, to help in sorting and bottling specimens, as well as to study some of them, and to consult books. "January 6th. Stephens spent all the morning with me, looking up Fish-books, &c." "January 11th. Stephens came in about 11.30 a.m., and remained to luncheon. He is studying the fishes of Port Jackson." "January 15th. Stephens spent the forenoon here, sketching and looking-up fishes."

1876.

Erection of Museum Building and removal of Collections.

The Journal for this year was kept regularly from January 26th to October 27th, but intermittently thereafter. It is the record of another busy year's earnest efforts to enlarge the Macleay Collection, and to perfect its arrangement. The important events of the year were—the erection of a Museum-building in the lower garden, and the removal of the collections, with the exception of the insect-cabinets, from Elizabeth Bay House thereto—Three important and several minor collecting-excursions were carried out by the Staff—Scientific work upon the *Chevert* collections was begun in earnest—The second year's record of the Linnean Society of New South Wales, was a great advance upon that of the first year.

The new Museum-building, 115 feet long, 36 feet wide, and 9 feet high, constructed chiefly of iron, erected at a cost of over £1,200, was finished in May; and, before the end of the month, the removal of the collections was begun, and, save for interruptions for other routine work, continued. Before the end of the year, considerable progress had been made with the transference and re-arrangement of the collections, with the exception of the entomological collections, in their temporary new home.

In anticipation of this, a skilled carpenter was engaged early in January to make glass-topped show-tables, cabinets, and fittings for the display of specimens; and he continued his work for the rest of the year. The bill for the glass alone for the cabinets and cases amounted to £33 1s. 3d. In addition, five cabinets, three large for birds, and two for shells, were supplied to order by the builder of the

Museum, at a cost of £160, on October 21st. A supply of glass-stoppered bottles for small specimens was obtained locally; and a consignment of oval glass jars ordered from England, arrived in September.

E. Spalding was engaged on January 27th, to mount Australian birds and small mammals. Spalding was interested in, and showed aptitude for, his work; and continued to be a member of the staff for the rest of the year.

J. Brazier was also engaged for a good part of the year, to help with the moving, and, when the new cabinets were available, to arrange the shells therein; and to complete his work on the *Chevert* mollusca. "January 27th. Brazier has now got through the shells of the *Chevert* expedition, about 3,000 species. He is now to give a list of them, with descriptions of the new species in papers to be communicated to the Linnean Society. He is to take the land-shells first." (Eleven papers in Parts ii-iv of Vol. i of the PROCEEDINGS).

The removal of the collections was to have begun on May 22nd, but two wet days and a holiday delayed progress. "May 25th. I commenced moving to the new Museum to-day. All the shells, and many of the tanks and jars of spirit-specimens were taken down." All the fishes in tanks were moved on the next day. Wet weather and routine interrupted the moving until "June 1st. In the afternoon we laid out one of the glass-topped tables in the new Museum with the Echini. The effect is good." On "June 3rd. We moved to-day about 150 of the mounted birds into one of the cabinets just finished." Two tables were arranged on July 4th, one with Star-fishes, and the other with the Darnley Island mummy and a number of human skulls. The large bird-cabinet and its contents, and other things were taken down on July 5th, and the larger Crustacea displayed on a table. Wet weather and other engagements caused interruption. On July 20th, the specimens of "corals were arranged in, and under one of the glass-topped tables." On the following day, all the bottled specimens of Echinoderms, soft Molluscs, and other marine forms were moved, and arranged in two glass-topped tables. The Australian and New Guinea native weapons, utensils, and ornaments, &c., were arranged on August 31st. After the new cabinets were delivered on October 21st, some of the shells were arranged and put away in two of these. After this date, no further particulars are given.

Collecting Excursions.—Some important collecting was done during the year. William Macleay and G. Masters left Sydney on March 11th to visit Kerarbury, the Station on the Lower Murrumbidgee in which William Macleay had an interest, returning on April 17th. At this time, the Southern Railway was opened only as far as Gunning. William Macleay's buggy and pair were in readiness, and the journey was continued, by easy stages, via Yass, Jugiong, Gundagai, Tarcutta, Wagga, Currawarner, Narrandera, and Waddi to Kerarbury. A week was spent at Wagga, and ten days at Kerarbury, the return journey being made by the same route. Collecting was carried out as far as possible, as opportunity offered. "Masters and I went out in the buggy, with our guns" on three days, at Wagga, and a number of birds were obtained, while some others were purchased from West. Masters also got a lot of fine Arachnida, under bark; some good specimens of a *Silurus* from a nearly dried-up lagoon; and a number of lizards. The Journal was not kept from March 24th to April 16th; but a summary is given in the entry for the 17th—"We got, during our trip, over 100 birds, many good, and six new to the collection; we saw others, but could not get them. We got also kangaroos, and a cask of reptiles and fishes", and, no doubt, other small things.

On June 21st, G. Masters, accompanied by Mr. Wharton Cox, left on a collecting-visit to the Mudgee district, returning on July 3rd. The results were—skins of three kangaroos, two wallaroos, seven wallabies, a native bear, and a young wombat; skulls of all these, and of phalangers, &c., together with entozoa.

"A very pleasant and satisfactory three days' excursion" to Broken Bay for the purpose of collecting fishes was carried out in September, "28th-30th. A small steamer was engaged, and I took with me Johnston as attendant and sportsman, Mulhall with his boat, carried on board, and Charles Hastie with his boat, and a man", and their nets and dredges. William Macleay was accompanied by W. J. Stephens and J. Brazier. The nets were hauled in the bays between Barrenjoey and Mullet Island; and line-fishing was carried on at night time. A large assortment of fishes, including "Pike, Long Tom, Taylor, Whiting, large Black Bream; among the smaller things, a good many *Gerres*; and an enormous haul of Rays." Several sharks were caught by line. "We took from a shark, with teeth like those of *Cestracion*, eighteen young ones, one foot long." Though the novelties, including "a *Julis* new to me", were not numerous, much knowledge and experience was gained, which were turned to account later on. Some good Mollusca were obtained from the keeper of the lighthouse at Barrenjoey.

"November 16th. A large male turtle was washed up on the beach here this morning. I have had him preserved."

Additions procured by the staff included—"Emu-wrens, and Bristle-birds, &c., ten in all", obtained by Masters at Long Bay; and "opossums, flying squirrels and native cats" shot at Canterbury, by Spalding.

"March 2nd. Masters got only one reed-warbler at Baptist's garden yesterday. They seem to have migrated, as they were numerous all the summer and bred plentifully. Kingfishers also have migrated within the last week."

Donations.—Mr. A. Boyd—the contents of one of the vats lent him for collecting in Fiji: "a great many fish, some snakes, lizards, crustacea, and echinoderms; but many of the fish and some of the snakes were soft and damaged, as he had lost most of the spirit I sent him". Also two human skulls, a number of birds, birds' eggs, shells and insects, &c., all from Fiji. Mr. Henry Bloomfield—"left two boxes of insects at the Club for me, said to have been collected by a Chinaman at Cooktown, but they seem to be all Chinese insects." Mr. Brazier—some specimens of corals. Count de Castelnau, Consul General for France, Melbourne—a bat from the Gulf of Carpentaria, and three fishes from the Yarra Yarra River (the Yarra Herring, *Gadopsis marmoratus*, and *Microperca yarrae* of Castelnau). Mr. Creswick, Coonabarabran—"three new species of *Carenum*, and six or seven of Amycteridae." "Signor D'Albertis visited me to-day (February 15th) and brought me a male and female of my *Mecynognathus Damelii* from Cape York." Captain Edwards—some beads, got by his son from the Natives of North-East New Guinea. Mr. W. J. Stephens "looked in this morning (October 1st) with his little boy, who brought me a welcome donation of birds' eggs". "March 8th. Brazier introduced Mr. ——— (name forgotten) from Port Denison, who presented me with three snakes." Miscellaneous, single donations were received from—Mr. Emerson "a fine shrimp, 8 inches long probably new"—C. Hastie, "a fine fish, name unknown, a Yellow-tail over a foot long and a new species of Flathead."—"October 17th. I got a new *Tetrodon* brought by Johnston."

Exchanges.—"November 25th. I have shipped by the Suez mail-steamer to-day a case containing insects and books (Parts of Proc. Linn. Soc. N. S. Wales, and *Trans. Ent. Soc. N. S. Wales*) for Dr. Dohrn, Baron de Chaudoir, and Dr.

Gestro of Genoa. I have also written to the last two, and Masters to the first." (No further particulars given.) Mr. H. Edwards, San Francisco—two consignments received May 6th and August 17th (particulars not given). Two sent, May 31st, three small boxes of New Guinea, Darnley Island and North Australian Coleoptera, &c.; and August 23rd, "207 species of Australian Lamellicorns, mostly named." Dr. von Haast, Otago, N.Z.—one consignment received, March 9th; one case containing 34 species of New Zealand birds, and another of Moa bones. One sent, May 9th, "over 1,000 species of Australian Coleoptera, about 150 species of Australian shells, two birds (desiderata), and specimens of Nickel-ore from New Caledonia, and cinnabar from Queensland." Mr. F. G. Waterhouse, Adelaide—one consignment sent, May 10th: "six birds (desiderata), and a specimen of *Dendrophis gracilis* mihi."

Purchases during the year were obtained from.—Mr. A. Boyd—nine Fijian skulls. Mr. Brazier—Tertiary fossil shells, chiefly European. Mr. Broadbent—a small collection of Australian birds (particulars not given). Mr. James Cockerell —a collection of Mammals (including fifteen Bats), Birds (about fifty), Insects (including about 300 Lepidoptera, many very fine), and a few other things from New Britain, New Ireland, and Duke of York's Island. Mr. Damon, Weymouth, England—an extensive order for fossils, fish-casts, &c. Mr. Duboulay—a small collection of bats and other things. Mr. Goodman, San Francisco—a few birds' skins and eggs. Mr. Gruber, San Francisco—eight species of small mammals, and 97 of birds (over 50 of them previously received). "May 31st. I wrote to Gruber, giving him a list of the birds I want, and offering to take large as well as small Mammals." Mr. Llewelyn—a box of butterflies (no further particulars). Messrs. Petterd and Broadbent—a collection of Mammals from New Guinea. Mr. Petterd— Tasmanian mammals, Birds ("10 species new to my collection"), nests and eggs, fishes, 200 species of Shells, Echinoderms, and Crustacea. Mr. Palmer—two fine specimens of the Impey Pheasant, and four Himalayan Pheasants. Pacific Naturalists' Agency, San Francisco—a cask of marine forms, fishes, crustacea, &c. from the Gulf of California. Mr. Waller, Brisbane—four Javanese musk-deer, of three species; a racoon and a lynx; twelve foreign birds, a few from the Dutch Archipelago and Australia; and rare eggs of a Heron. Mr. Webb, King George's Sound—twenty-one mammals, and 78 birds, "some of both very good, seven of the birds new to my collection", from Western Australia.

Other purchases from sources not mentioned include—"May 8th. I bought a lot of birds to-day" (particulars not given). "July 5th. I bought some birds this morning (desiderata)" (possibly from Palmer). "July 14th. Masters and Spalding got specimens of the Banded Stilt, three species of Ducks, and a Coot this morning, out of a large and varied assortment of birds sent from Melbourne to some shops here." Remarks on these specimens are given by E. P. Ramsay in his paper "Remarks on the large number of Game Birds which have of late been offered for Sale in Sydney" (Proc. Linn. Soc. N. S. Wales, Vol. i, p. 215). "July 25th. Spalding got to-day a pair of Native Companions, and pink-eyed Ducks, at the Market"; and, on July 28th, "a blue-billed duck and a teal." "October 7th. I got some very curious figures in chalk, or something like it, from New Ireland." "November 6th. I have made several purchases of birds, &c., for the Museum, within the last week" (no further particulars given). The amount expended on the above-mentioned purchases was about £300.

Under much pressure from other engagements, but desirous of taking his share of the task of contributing papers, William Macleay notes in his Journal on

April 19th. "I am going to set to work at once on the Coleoptera of the *Chevert* expedition". A short paper "Notes on some New Guinea Coleoptera" was read at the Meeting on May 29th. "It was my wish and intention to have given you, on the present occasion, a complete description of the Coleoptera collected during the cruise of the *Chevert*. I have been unable, I regret to say, from various causes, to carry out my intention as a whole, but I now lay before you, as an instalment, a few notes on those of the Geodephagous Coleoptera of New Guinea, which were taken during the voyage. . . . The six species which I now describe were the only representatives of the families Cicindelidae and Carabidae, taken at Katow and Hall Sound, notwithstanding a diligent search by experienced collectors."

On June 27th, the entry includes the following—"I commenced upon the fishes of the *Chevert* expedition to-day. I shall give up a few hours every day to it. Dr. Alleyne is to join me in the work." From June 28th to September 25th, Dr. Alleyne went to Elizabeth Bay thirty times; but towards the last he was often expected, when he was unable to come. "August 12th. Alleyne came to-day. We have now finished our examination of the fishes for the determination of the genera. We have now to go over them again to fix the species. There must be little short of 250 species in all." William Macleay finished a draft of the paper, and submitted it to his colleague, on September 19th. This was returned the next day approved. An artist, engaged to figure the 48 species described as new, finished his work on October 19th. The paper, in two Parts, was read at the Meetings on September 25th and November 25th. Only the Teleostean fishes were dealt with. Part 1 takes account of 54 species, 22 described as new; and Part 2, 91 species, 26 considered to be new. "The Sharks and Rays, of which there are a considerable number, will probably be made the subject of another paper, but we have no immediate intention of proceeding with the investigation of them."

The entry for October 23rd includes—"I am busy preparing a paper on the Entomology of New Ireland." A short paper, "Notes on the Entomology of New Ireland", giving a general account of the entomological collection purchased from Mr. James Cockerell on October 16th, the notes being intended to give a general idea of the entomological fauna of the Island, was communicated at the Meeting on October 30th.

Visitors.—In addition to the regular periodical visitors, Dr. Badham, Dr. J. C. Cox, Mr. Dalley, W. J. Stephens, and Sir Edward Deas-Thomson; and to visitors to Sydney, who were entertained at Elizabeth Bay House, and were shown the collections, such as Mr. and Mrs. Scott Siddons, and the Bishop of Tasmania; the scientific visitors included—Dr. Alleyne, who came on April 26th, "to look over my Murrumbidgee fishes"; as well as, many times to work, in collaboration with William Macleay, at the fishes of the *Chevert* collection.—Mr. Archie Boyd, four visits between February 15th and July 7th, after his return from Fiji, bringing specimens collected there, and before returning again, further equipped with a dredge and a meshing-net, &c., by William Macleay for additional collecting.—Count Castelnau, on a visit from Melbourne, came to lunch on June 22nd. "He was very unwell, but spent about an hour and a half looking at insects, fishes, &c."—Sir Daniel Cooper called on September 13th, and saw the Museum.—Signor D'Albertis, then on a visit to Sydney, making arrangements for a second visit to the Fly River, New Guinea, came to lunch on February 9th. "I showed him the insects and other things he wished to see, and presented to him the two volumes of the *Transactions of the Entomological Society of New South Wales*." On the occasion of a second visit on February 15th, "he brought me the sexes of

Mecynognathus Damelii mihi, from Cape York."—"Mr. Veitch, of London, who, for the last year, has been collecting plants in Fiji, and the New Hebrides group, called here to-day" (October 20th), and, by invitation, came again the following day to luncheon.—Mr. C. S. Wilkinson, on February 18th, came to see the geological specimens and fossils obtained during the voyage of the *Chevert*. These were loaned to him for the preparation of a paper, which was communicated to the Society at the Meeting on February 28th.

By way of returning the hospitality extended to him by the Members of the Linnean Society of New South Wales on the eve of his departure in the *Chevert*, in May, 1874, William Macleay entertained the Members at a picnic to the Weatherboard (now the Wentworth) Falls, on February 12th, 1876. Upwards of fifty Members, together with Signor D'Albertis, and Mr. Way, Attorney General of South Australia, special guests, journeyed by special train to the Blue Mountains, leaving Redfern Station at 8.15 a.m., returning thereto at 7 p.m. "We stopped for three-quarters of an hour near Wascoe's, and had breakfast. Tables were laid out alongside the train, and hot fish and other delicacies were served, cooked on a stove in the guard's van. We then proceeded to the Weatherboard, reaching it at 11.50 a.m. We visited the water fall, and strolled about until 2 p.m., when dinner was announced, served on tables near the train."

The Hon. Mr. William Forster, who had succeeded William Macleay as Member for the Murrumbidgee, was appointed Agent-General for New South Wales in London, on February 8th. In anticipation of this William Macleay received invitations from some of his old friends, both at Wagga, and at Gundagai, asking him to accept nomination to fill the vacancy; but he steadfastly declined. He had been elected a Member of the Senate of the University on May 15th, 1875, three days before the departure of the *Chevert*, but was granted leave of absence. After his return and he had had time to settle down again, he attended the Meetings of the Senate regularly (from February 2nd, 1876), as also the Meetings of the Board of Trustees of the Public Library, and of the Australian Museum. With these engagements, together with the development of his Museum, his interest in the newly established Linnean Society, and some private business in connection with his vineyard at Wagga, his time was fully occupied.

1877.

The Journal was not kept for this year. The only source of information about William Macleay's scientific work, and additions to the Macleay Museum during the year is three of the papers contributed by him, and one by G. Masters in Volume ii of the PROCEEDINGS. From these it appears that E. Spalding spent about five months, from May to September, collecting at Port Darwin. In a short paper, "On some new Carabidae from Port Darwin", read at the Meeting of the Linnean Society of New South Wales on August 27th, William Macleay says—"about a week ago, I received from Mr. Spalding a large and valuable collection of Mammals, Birds, Reptiles, Fishes, Mollusks, Crustacea, Insects, and other animals, both terrestrial and marine, from Port Darwin, the capital of the South Australian Province of North Australia. The collection is extremely interesting, both in a zoological and geographical point of view." G. Masters gave an account of the Birds (106 species, one new, but a number of them little known, and rare in collections) at the Meeting of the Society on November 26th (Vol. ii, p. 269). William Macleay described the Snakes (thirty good specimens, 12 species) at the

Meeting on September 24th (Vol. ii, p. 219); and the Fishes (about 120 species, 21 described as new), at the Meeting on December 31st (Vol. ii, p. 344).

In the earlier part of the year William Macleay had studied and reported on the Ophidia, Lacertilia, and Batrachia obtained during the *Chevert* Expedition.

1878.

With the exception of two brief entries on 10th and 24th May, the Journal for 1878 was not kept. The first is a brief record of the fact that William Macleay had written to Dr. Bidie, of the Madras Museum, about exchanges; and of money sent to Mr. Webb, of King George's Sound, for specimens recently received (without particulars). The second is an equally brief record of correspondence with Count Castelnau, of Melbourne, about the genus *Ambassis*, and a list of Australian Mollusca, without further particulars.

Four short papers—on a species of *Therapon* from a dam at Warialda, a new snake, ten new species of fishes from Port Jackson or King George's Sound, a new species of *Amphisile* from the Palau Islands—together with a note on the power of locomotion in the Tunicata, and a joint paper with Miklouho Maclay, on the Plagiostomata of the Pacific, Part i, contained in the PROCEEDINGS for this year (Vol. iii), afford no light on the progress of the Macleay Museum during 1878.

1879.

The Journal for this year is fairly complete. It is the record of a notable year, during which William Macleay's activities covered a wider field than usual, to an extent which somewhat interfered with his regular programme of scientific work. Special circumstances were responsible for this new departure, chiefly the International Exhibition, which was opened on September 17th, 1879. The foundation-stone of the Exhibition Building, specially erected for the purpose in part of the Inner Domain, since then known as the Garden Palace grounds, was laid by Lady Robinson, wife of the Governor, on February 13th. The building, when nearing completion, was named The Garden Palace, in the Government Gazette of September 2nd.

The Commissioners for organizing the Exhibition, were appointed in December, 1878, William Macleay being one of them. The first Meeting of the Commission was held on January 14th, when Committees were appointed. William Macleay was appointed to three of these, namely, those for Animal Products, Printing, and Scientific Instruments and Appliances, and was Chairman of the first of them. Henceforward, weekly Meetings claimed his attention up to the time of the opening, and Meetings of some kind until the Exhibition closed in March, 1880, and the business in connection therewith was concluded. The Exhibition attracted many visitors from the other Colonies, and elsewhere. Some of these were not only naturalists, but official representatives of the States or countries from which they came. This prepared the way for pleasant and fruitful intercourse with the scientific men resident in Sydney.

On January 8th, 1879, the Senate of the University appointed a Committee, comprising Canon Allwood, William Macleay, and Dr. Renwick, to report on the requirements of a contemplated Medical School. The Committee met twice, and sent on its report to the Senate on January 29th, recommending that the proposed site, on the land vested in the Prince Alfred Hospital, was unsuitable, and suggesting a better one for temporary buildings.

Parliamentary duties in the Upper House also claimed more than ordinary attention.

William Macleay's scientific work during this year was much interrupted by attendance at weekly Meetings throughout the year in connection with the Exhibition, and by the correction of proofs, and the oversight of the publishing of the PROCEEDINGS OF THE LINNEAN SOCIETY OF NEW SOUTH WALES. Nevertheless, as far as circumstances permitted, he devoted much attention to scientific work and the study of fishes during the year, and contributed three papers at the Meetings of the Linnean Society in January, July and October, one descriptive of the fishes brought by Cockerell from the Solomon Islands, the other two on the Clupeidae, and the Mugillidae of Australia. William Macleay's interest in fishes was primarily scientific, but as Chairman of the Exhibition Commission dealing with Animal Products he was interested in the question of satisfactory exhibits of local fish-products. In the paper on the Clupeidae he pointed out that Herrings were very rarely seen in the Sydney Fish Markets because the shoals pass the Heads in the winter months, proceeding in a northerly direction, as a rule, without entering the harbours; and that to fish for them in the open sea would require appliances not at present in the possession of our fishermen. He pointed out the importance of learning more about the movements of the migratory shoals, and expressed his willingness to receive and register any observations on these matters sent to him, in the hope of directing public attention to the great value of our undeveloped fisheries. The paper on the Mugillidae was read at the October Meeting, shortly after the Exhibition had been opened. This was another effort to direct public attention to the great value of our undeveloped fisheries.

Other material studied included Fishes from Fiji, the Muraenidae in the Macleay Museum, the fishes from Port Darwin in the Australian Museum, snakes from Sourabaya, the fruit-eating bats in the Collection, South Australian Lepidoptera of which drawings were sent by Professor Tate, on behalf of Mr. Tepper, and Entozoa and Epizoa of the Port Jackson, and other sharks.

Another supply of glass-jars, contained in five casks, imported from England at a cost of £119, was received on March 28th. These were utilized for the display of the fishes and other spirit specimens obtained from the Solomon Islands and Fiji, and the Holothurians and other spirit material, previously stored in bulk, obtained during the *Chevert* expedition. Other routine work included the putting away of the new material acquired, and the making up and despatch of collections sent in exchange. The Rev. Tenison Woods assisted in selecting Echini for despatch to Prof. Loven.

There was no opportunity for country excursions, but Masters and Spalding visited Long Bay for collecting purposes, especially for reptiles, in June. Masters went to Bondi after heavy gales on May 6th and obtained an eel, *Congomuraena habenàta*, a *Sagitta*, and some examples of *Spirula* with the animal not quite perfect.

Visitors to Elizabeth Bay were more numerous than usual, in consequence of the Exhibition, some of those interested in Natural History being official representatives of the Colonies or countries from which they came. They included Mr. Casey, the Executive Commissioner for Victoria, and Mr. Pigdon, also a Commissioner, introduced by Mr. W. H. Archer; Mr. Croall of Edinburgh and a friend, "introduced by my sister, Isabella"; a party of officers of the French

Warship *Victorieuse*, introduced by Mr. W. H. Archer; Dr. J. Hector, of the Museum at Wellington, and Dr. von Haast, of the Otago Museum, Dunedin, both Exhibition Commissioners for New Zealand (both attended the Meeting of the Linnean Society on September 24th. William Macleay exhibited his general collection of Silurian and Devonian fossils from the neighbourhood of Yass, and W. J. Stephens a collection of Trilobites from the same beds. It was a very interesting Meeting. The following week, Dr. Hector, accompanied by Prof. Loven and W. J. Stephens, went for a geological excursion. William Macleay was to have been one of the party, but was unable to carry out his intention.); Mr. E. L. Layard, British Consul at Noumea (interested in ornithology, and came to see the Museum, especially the birds from the New Hebrides. He subsequently sent two collections of New Caledonian birds); Mr. R. Walker; The Hon. Louis Hope, and W. H. Miskin, entomologist, both from Queensland; Mr. F. G. Waterhouse, Curator of the South Australian Museum, from Adelaide.

Donations were received from:—Mr. Anderson, New England—two Avocets; Dr. Alleyne—a very fine specimen of a marine Annelid (*Nereis*); Mr. Brenan—a large diamond-snake, 8 feet long, which had swallowed a small wallaby, captured at George's River. "It is to be stuffed"; Dr. J. C. Cox—a fine specimen of *Ibacus* from Port Stephens; an iguana, for the preparation of its skeleton; "a few Solomon Island things; a fish, a recent Echinus, and a fine fossil one; a lot of Echini, some good Comatulas, and other marine things, as well as a snake (*Hoplocephalus pallidiceps*) I had not before seen", all from Port Stephens; Mr. R. Cox, Mudgee—"a couple of Blennies from a waterhole, near his place"; The Hon. W. B. Dalley—three fishes (a flat fish, a large Blackfish, and a Chelmo); Mr. Dease, Kempsey—the rib of a whale, and the pelvis of a horse; Mr. Ebsworth—a fine full-grown, female specimen of the Saw-Shark (*Pristiophorus cirratus*), with five large eggs in the oviduct [this specimen was exhibited at the Meeting of the Society on October 29th (Proc., Vol. iv, p. 458), by William Macleay, as the first specimen caught in Port Jackson, known to him]; Mr. Layard, Noumea—two consignments: a case of birds from New Caledonia, all new to the Collection, received June 8th (without further particulars); "some birds arrived to-day from Layard, New Caledonia", without further particulars, received on October 28th; Dr. Hector, Wellington, N.Z.—New Zealand birds and fishes (particulars not given) received on September 4th; Mr. Long, Sydney—a fine male musk-duck; Mr. Marshall, Angaston, South Australia—trapdoor-spiders' nests, and specimens of copper-ore, &c.; Mr. E. Merewether—a potato infested with the larvae of a moth (the specimen was referred to Mr. E. Meyrick, who contributed a note "On a Micro-Lepidopterous Insect destructive to the Potato" at the Meeting of the Society on February 26th, Proc., Vol. iv, p. 112); Mr. Williams, formerly first mate of the *Chevert*, afterwards in charge of a pearl-shell fishery in Torres Straits —three species of snakes, a lizard, some small fishes, &c., and a fine coral growing on a pearl-shell; also two large Chinese vases. The donor visited Sydney in September, and, on his return, was supplied with a jar of spirit, as "he has promised to collect for me"; Rev. J. E. Tenison Woods—a collection of dried Fungi.

Exchanges were carried out with: Dr. Bidie, Madras—one consignment, of about a score of small mammals, and 200 species of birds, received on May 28th; one, a cask of fishes (103 species), and a box of Echinoderms, sent on July 3rd; Mr. Du Cane Godman, London—a box of Lepidoptera (Papilionidae and Morphidae) received December 15th; one consignment of Diurnal Lepidoptera sent in April;

Dr. Hector, Wellington, New Zealand—New Zealand birds and fishes (particulars not given), received on September 4th; Count de Lansberg, Governor-General of Java, Batavia—arrangements for exchanges were made, and one consignment of Australia Coleoptera, chiefly Lamellicorns, sent on December 1st; returns received in the following year; Professor Loven, Stockholm—a box of Echini, selected by Rev. J. E. Tenison Woods, sent in June, in exchange for Arctic species (received in January, 1880); Dr. H. de Saussure, Geneva—one consignment of five boxes of Hymenoptera (350 species) and Orthoptera (200 species) sent in February, 1880.

Purchases were made from: Mr. A. Boyd, Fiji—seven consignments of specimens from Fiji and the New Hebrides, received during the year; native weapons and implements, osteological specimens (human), and 10 species of fishes in spirit, "new to me and in capital condition"; corals, crustacea, and some very good small fishes in spirit, "several new to me"; spirit-specimens of two lizards, small but very good fishes, "most of them new to my collection", echinoderms, and crustacea, together with some fossil shells; another consignment, "not so good as the last" (particulars not given); several skins of Hawks and Owls, an edible bird's-nest, and a good collection of sea-snakes and fishes in spirit, from Fiji, Mallicolo, and other islands; a few birds and eggs, fishes, including about a dozen species from Espiritu Santo, and crustacea; fishes, "one new to me", and crustacea; Mr. Cockerell—part of his collection (mammals, birds, over 100 species, reptiles, fishes and insects) from the Solomon Islands; Mr. Goldie—three birds, and about 130 species of Coleoptera, from New Guinea; Mr. Goodman—a collection of mammals, birds, and spirit-specimens (not particularized), from the Richmond River; Mr. Webb, King George's Sound—two consignments; mammals and birds, one Black Cockatoo new to the Collection; a few birds, one Petrel new to the Collection, and Crustacea, all from Western Australia. A large and important assortment of fishes, especially two School Sharks, both females, one full of young; one large Hammer-head; Plagiostomata (12 species, in addition to two presented), supplied by fishermen, especially by C. Hastie, Heaney and Andrews, including—two young Whalers; two Blue Pointers, one about 7 feet long, caught outside the Heads, the other, a female, about 5 feet long; one White Pointer, about 10 feet long, a female; a small Grey Nurse, about 4 feet long; a fine Thresher, "the first I have heard of being caught here"; two large Wobbegones, one a male, 6 feet 8 inches long; three Port Jackson Sharks; one Angel Shark; and a fine Ray (*Trygon*); a medium-sized perfect male of *Heterodontus galeatus*, a fine adult female, 3 feet 6 inches long, and a young one, with the first dorsal spine covered with barnacles. The Entozoa and Epizoa from these were preserved. Five of the Sharks were exhibited at the Meetings of the Society (Proc., Vol. iv, pp. 292, 311, 458, 571). Teleostean fishes, also supplied by fishermen, included specimens of *Lobotes*, *Scorpis*, Bluefish (*Girella*), *Chilodactylus* (two species), *Beryx*, *Temnodon*, a Scomber-like fish, *Echineis naucrates*, *Myxus*, *Cossyphus*, *Clupea sundaica*, *Muraena*, *Monacanthus* and small Schnappers. A fisherman also brought a specimen of a sea-snake from Terrigal.

Other important purchases were—some large Coleoptera from New Guinea (without further particulars) per G. Masters; a few bird-skins, "one, a South African Cuckoo, very beautiful"; "a collection of snakes, lizards, &c., over 100 specimens, mostly small things, in spirit, from Sourabaya", bought at an auction sale (per E. Spalding); a fine, young male Fallow-deer, and a stuffed seal (sea-lion), about 10 feet long (per E. Spalding).

The following experiences were noted—"May 12th. I saw a wonderful catch of 'Hardiheads' (*Atherina*) in the Bay this morning. The net was actually full of them." "June 28th. Hasty drew the seine on the beach early this morning, and completely filled his boat with Herrings (*Clupea sundaica*) and Tailor. He left bushels of them on the beach, which we found lying there when daylight came in." This was the catch referred to in William Macleay's paper on the Clupeidae (Proc., Vol. iv, p. 372).

1880.

The Journal for the year 1880, with numerous blanks, ends with the entry for April 15th. The Royal Commission, to inquire into and report upon the actual state and prospect of the Fisheries of the Colony, for the appointment of which the Legislative Council, on the motion of William Macleay, had passed a resolution on December 18th, 1879, was appointed by His Excellency, the Governor, Lord Loftus, with the advice of the Executive Council, on January 8th, 1880. The Commission comprised fourteen Members, including William Macleay, who, by request of the Premier, Sir Henry Parkes, consented to act as President, Dr. J. C. Cox, the Hon. W. B. Dalley, Captain Hixson, Alexander Oliver, E. P. Ramsay, and eight others. Charles Lyne was appointed Secretary. The Commission held its first Meeting on January 9th, and thereafter on three days per week until May 3rd, total thirty-one Meetings. One of these was held at Wagga on March 13th, in order to take evidence about inland fishery matters. Thirty-five witnesses, the majority of them fishermen, gave evidence. Much documentary information was obtained from pilots, lighthouse-keepers, and others stationed at the more important, distant coastal harbours, and residents interested in fishing who were unable to attend personally. The information forthcoming from all sources was sifted, reviewed, and supplemented, and with certain recommendations, such as the appointment of a permanent Commission of two or three competent gentlemen to exercise entire supervision of all fisheries, was incorporated in a valuable Report, which, together with the minutes of evidence, and an appendix including fourteen short popular articles on "Fishes of and Fishing in New South Wales", by the late Mr. E. S. Hill, reprinted from the *Sydney Mail* for 1874, was presented to the Legislative Council, and ordered to be printed on May 13th, 1880; and was published shortly afterwards. The Report alone was subsequently issued separately.

To appreciate the importance of the information systematically brought together in this valuable Report, it should be compared with the limited knowledge previously available, as given in Alexander Oliver's Essay on "The Fisheries of New South Wales", published in the Report of the Intercolonial Exhibition of 1870, at Sydney (p. 781, 1881).

William Macleay's interest in the operations of the Royal Commission, and his efforts to promote their success, though primarily the outcome of the interest he had been taking in ichthyology since 1874, were stimulated by his intercourse with the fishermen who had procured specimens for his collection, and supplied information about the breeding and other habits of food-fishes; as well as by the experience gained as Chairman of the Committee of Animal Products in connection with the Exhibition, which was still open. By his direction, G. Masters arranged a series of exhibits of the more important fishes of economic value, for the inspection and enlightenment of the Commissioners and witnesses, and for the identification of the species known to the latter by vernacular names. On February 23rd, William Macleay notes in his Journal that he had attended a Meeting of the Commission in

the forenoon; and that, in the afternoon, he had begun to work at part of the Report—no doubt a draft of the first Section of the Report on "Our Marine Fishes". But the Journal is incomplete, and ends before the Commission had finished its work.

The Journal is too incomplete to give a satisfactory account of William Macleay's scientific work during the year. Besides the work done in connection with the Royal Commission, he began a paper on the Fishes of Fiji, as noted in the Journal for January 5th; but this was not completed. Four papers—on a new species of *Galaxias* from Mount Wilson, on two undescribed fishes well-known to fishermen, brought to notice by the investigations of the Fisheries Commission; and Parts i and ii of a Descriptive Catalogue of the Fishes of Australia were communicated to the Linnean Society of New South Wales, during the year. The Descriptive Catalogue, based, with due acknowledgment, on Dr. Günther's British Museum Catalogue of the Fishes of the World, in 8 volumes, was intended to bring the record of Australian fishes up to date, and to present it in a more convenient form for those undertaking the study of Australian fishes.

Donations were received from: Mr. John Anderson—a basket of *Galaxias* from Mount Wilson; Mr. James Ramsay—a small collection of insects, including a fine *Carenidium*, from Fort Bourke; Rev. J. E. Tenison Woods—a fine collection of Fungi, mostly dry ones growing on wood.

Exchanges were carried out with: Count de Lansberg, Batavia—one consignment received January 14th, two boxes, one containing the skins of three fine large monkeys, a squirrel, and another small mammal; the other, spirit specimens of fishes and echinoderms. A second despatch was advised later, in March, but there is no record of its receipt; Professor Loven, Stockholm—one consignment of Echinoderms (some of the Echini much broken in transit) received on January 7th. One consignment, "a large collection of named Crustacea, and of unnamed Echinoderms in spirit," sent on February 2nd; Dr. Henri de Saussure, Geneva—one consignment, five boxes of unnamed Hymenoptera (350 species) and Orthoptera (200 species), sent on February 2nd.

Purchases were made from Mr. A. Boyd, Fiji—two cases, containing skulls, fishes, &c., without further particulars, received on March 15th.

Two fishermen supplied a Sooty Albatross, and a fine Tiger Shark, 11 feet long, both caught in Port Jackson. The only other acquisition mentioned is a specimen of *Nectris*, well known in New Zealand, but an addition to the Australian avifauna, found dead on the beach at the bottom of the garden, by the gardener.

1881.

The Journal for this year, the last of the series, contains but seven entries, the final one for June 15th. These chiefly relate to exchanges, and other additions to the Macleay Museum. But the first records that the sixth Annual General and the Monthly Meetings of the Linnean Society of New South Wales, held on the 27th January, were largely attended. Also that—"I am working at present at (the continuation of) a Catalogue of all the Australian Fishes, and have made such progress that I expect to finish in two months. The number of species will be about eleven hundred. Baron Maclay has returned to Sydney. I gave him, two days ago, a fine fresh specimen of *Heterodontus galeatus*."

The Catalogue, comprising 1,133 species, was finished on March 6th. Parts 3 and 4 of the "Descriptive Catalogue" were communicated to the Society at the

Meetings on January 27th and March 30th, as printed in Vol vi of the PROCEEDINGS Two other papers—on a species of the Phasmatidae destructive to Eucalypts; and descriptions of two new species of Snakes from near Bourke, N.S.W.—were contributed at the Meetings on April 27th, and November 30th. The Journal is too incomplete to throw any further light on the scientific or routine Museum work during the year.

When the Garden Palace Exhibition was closed in March of this year, and the exhibits had been removed, the Government decided to retain the building. Provision was made for housing therein, the Department of Mines, established in 1875, and the newly instituted Technological Museum. By permission of the Government, the Linnean Society of New South Wales was allowed to occupy two rooms. As the building was closed at night time, the Monthly Meetings were held in the Board Room of the Public Library, by permission of the Trustees. This prospect of a permanent home for a time, at any rate, greatly stimulated the Society. The donations to the library and exchange-relations with other Societies were steadily growing in importance.

At the eighth Annual Meeting, on January 25th, 1882, Dr. Cox in his Presidential Address, thus referred to these matters—"I can safely congratulate the members on this the close of the seventh year of the Society's existence, that the wishes and hopes expressed for its prosperity and stability by the first president, the founder of this Institution, in his inaugural address, have been up to the present time satisfactorily fulfilled; for during the past year the list of members has steadily enlarged, the contributors to the 'Proceedings' have increased. . . . The donations and loans of books of a varied and reliable nature, appertaining to natural history, have greatly exceeded in number and value the gifts of the previous year; and our library now will bear, in its excellence, more than a fair comparison with those of other kindred self-supporting associations. This exceptional acquisition is due to the liberality of the founder of this Society, Mr. Macleay, by his recent munificent gift, being the second of a similar nature, of standard and scientific works exceeding 600 volumes. The loan also by the same gentleman, consists of a large number of works peculiarly suited to our wants."

Particulars of William Macleay's two munificent gifts of books and a loan of additional volumes are not given in the PROCEEDINGS.

The President further continued—"Beyond these seasonable favours in aid of our Society, Mr. Macleay lately at his own cost caused a course of free lectures on the animal kingdom to be given, and engaged the services of Mr. Haswell, a gentleman thoroughly competent to do the good work. These lectures were well attended and appreciated. . . . This liberal behaviour in the cause of Science has elicited an appropriate response on the part of the Government; two rooms at the Garden Palace have been set apart for the Society—the one to be used as a library, a lecture-room, and as a meeting and reading-room for the members; the other specially as an office for the transaction of business by the Council of the Society." (PROC., Vol. vi, p. 847-848).

Donations were received from: Mr. Williams—several species of beautiful Gorgonias, Sponges, and a few shells from Torres Straits, "all apparently brought up by a diver."

Exchanges were carried out with: Dr. Bidie, Madras—one consignment, a cask of (presumably Indian) fishes, received on March 23rd; one, sent on February

22nd, comprising skulls, birds, crustacea, and three mammals in spirit; Mr. Henry Edwards, New York—one consignment, over 800 specimens, over 200 species of Australian Lepidoptera, sent on March 22nd; Count de Lansberg, Batavia—one consignment of small fishes in spirit from Amboyna, Flores, and Dorey, received in January; one of Coleoptera, about 150 species of Heteromera, and 250 of Phytophaga, &c., sent on February 18th. A letter was received from Professor Loven, on June 15th, acknowledging receipt of the last consignment, and promising a return, fishes, &c., at an early date. But there is no record of their receipt.

Purchases were made from: Mr. A. Boyd, Fiji—spirit-specimens of fishes, crustacea, mollusca, &c., from Espiritu Santo, Solomon Islands, and the New Hebrides, received on March 14th; Mr. A. Goldie, Port Moresby—a fine collection of fishes from New Guinea; over 150 species, received on June 15th.

After 1881.

After William Macleay ceased to keep his Journal in June, 1881, some important additions were made to the Macleay Collection, as mentioned in his own or in E. P. Ramsay's papers in the PROCEEDINGS, Vols. viii-xii.

In a paper, "Contributions to the Zoology of New Guinea, Part vii", the latter says—"I have received from Mr. Wilson of Mason Bros., collections containing over 1,000 skins collected by Messrs. Rolles and Hunstein, and other members of Mr. Goldie's party; I have also been permitted to examine a collection lately added to the extensive collection at Elizabeth Bay." Several new species of birds were described, of which E. P. Ramsay says—"For the pleasure of describing these species I am indebted to the Hon. William Macleay, who purchased them with a collection of birds of Mr. Goldie" (Vol. viii, pp. 16, 25). There are also references to other specimens in "Mr. Macleay's Coll."

In two papers in the same volume—"On a new and remarkable Fish of the Family Mugilidae, from the Interior of New Guinea"; and "Contribution to a Knowledge of the Fishes of New Guinea, No. 4"—William Macleay gave an account of a second collection of Fishes supplied by A. Goldie. These were obtained in the extreme south-east of New Guinea, including collections made at Hood Bay and eastward to the D'Entrecasteaux Group of Islands. The first collection from Port Moresby comprised 274 species. The second collection increased the number of species to 405.

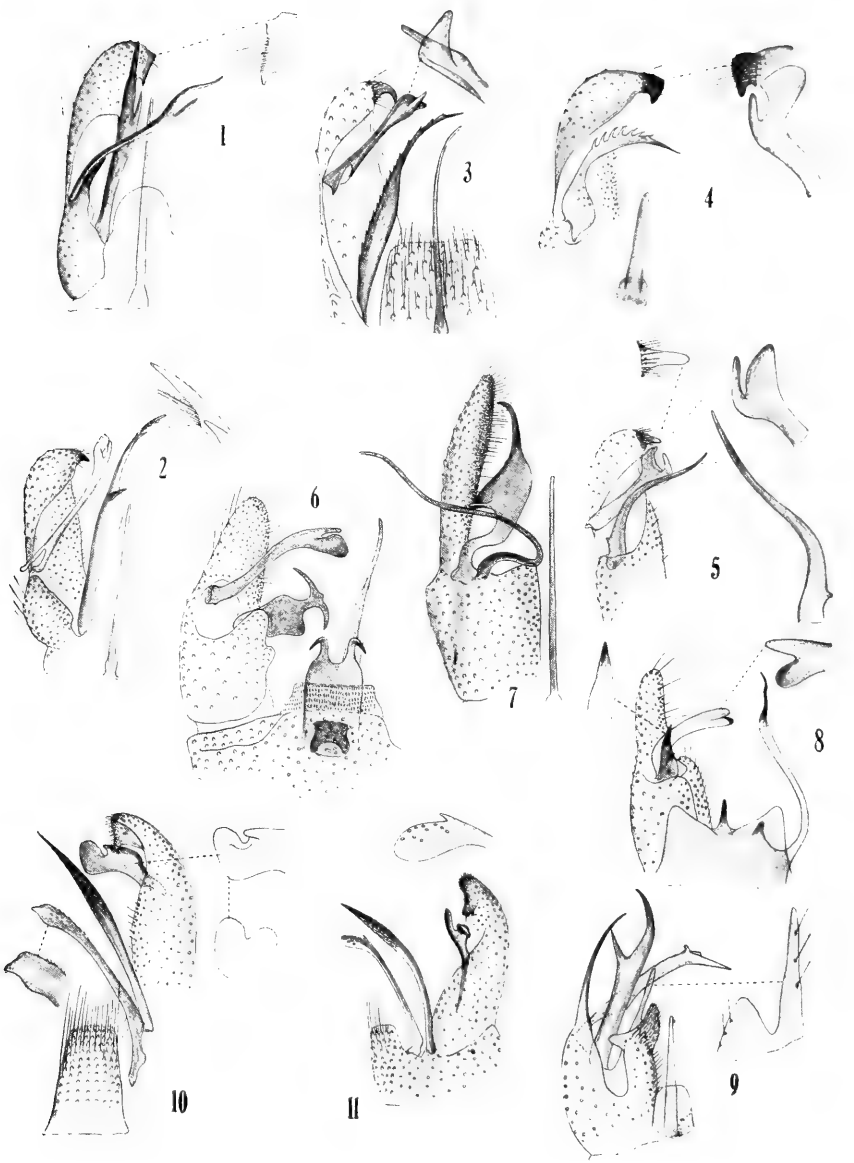
Volumes viii (p. 432) and x (p. 64) contain William Macleay's acknowledgments of the receipt of specimens from the Herbert River, North Queensland. In the second of these, he says—"I have frequently, within the last two years, received from my friend, Mr. J. A. Boyd of Ripple Creek, Ingham, collections of Mammals, Reptiles, and Fishes made in the vicinity of the Herbert River." The Reptiles from these collections were treated of in two papers in the Volumes mentioned.

A small collection of fishes from the upper waters of the Murrumbidgee, obtained and presented by Mr. C. Jenkins, of Yass, in May, 1885, prompted a paper by William Macleay, "New Fishes from the Upper Murrumbidgee", read at the Meeting of the Society, on June 24th, 1885 (PROCEEDINGS, Vol. x, p. 267).

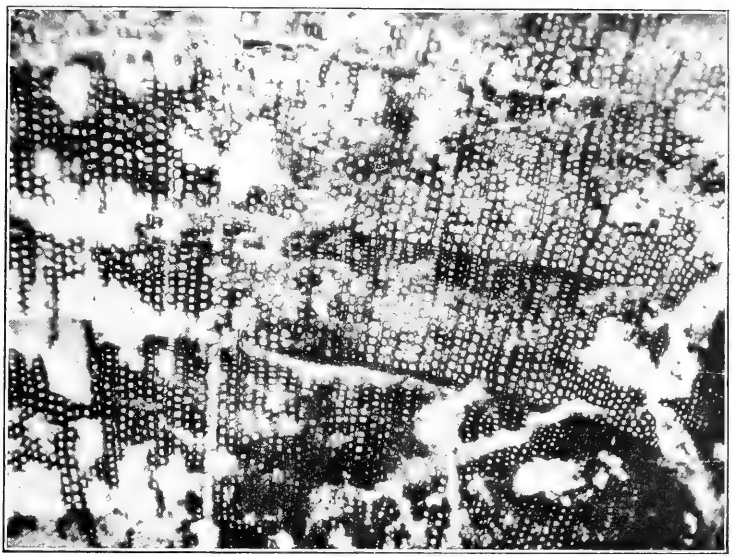
In a paper "Miscellanea Entomologica, No. i. The Genus *Diphucephala*" read on April 28th, 1886 (PROCEEDINGS, 1886, p. 395), William Macleay says of the type-specimen of *D. Barnardi*—"I have named this species after George Barnard, Esq., of Coomooboolaroo, Upper Dawson, from whom I have received this and many

other rare and beautiful insects." A reference to a visit from Mr. Barnard, and the names of some of the insects in his collection will be found in the PROCEEDINGS for 1887, p. 972.

[Mr. Fletcher, on more than one occasion, told me that he had accepted the private Journal of Sir William Macleay on the understanding that, when he had abstracted references to affairs concerning the Linnean Society, he would reverently destroy the Journal since it contained much information of a private and confidential nature. I have, therefore, not omitted from the above Address any of the extracts quoted from the Journal, since they are no longer available for reference.—A.B.W.]



Male hypopygia of species of *Molophilus*.



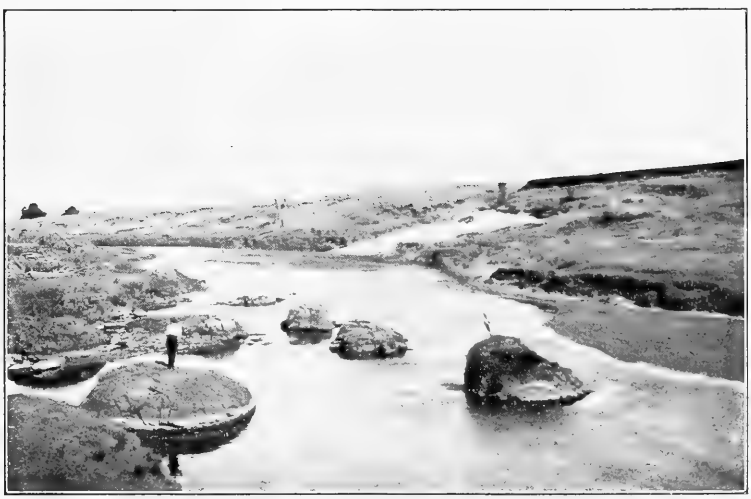
1

2

3

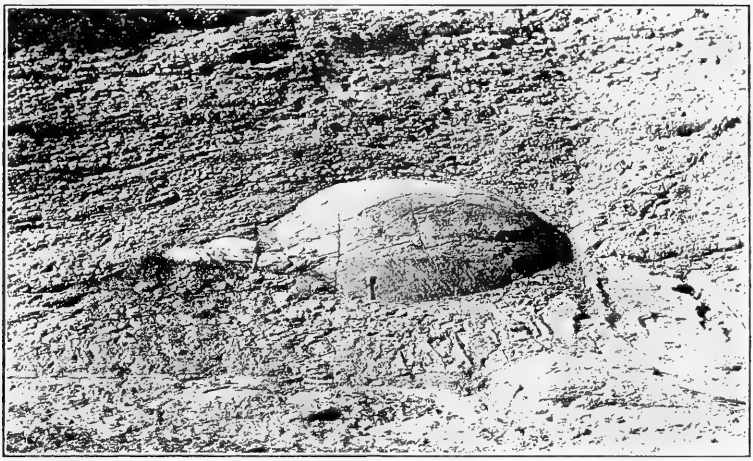
Coniferous wood from Cretaceous rocks of Central Australia.

1



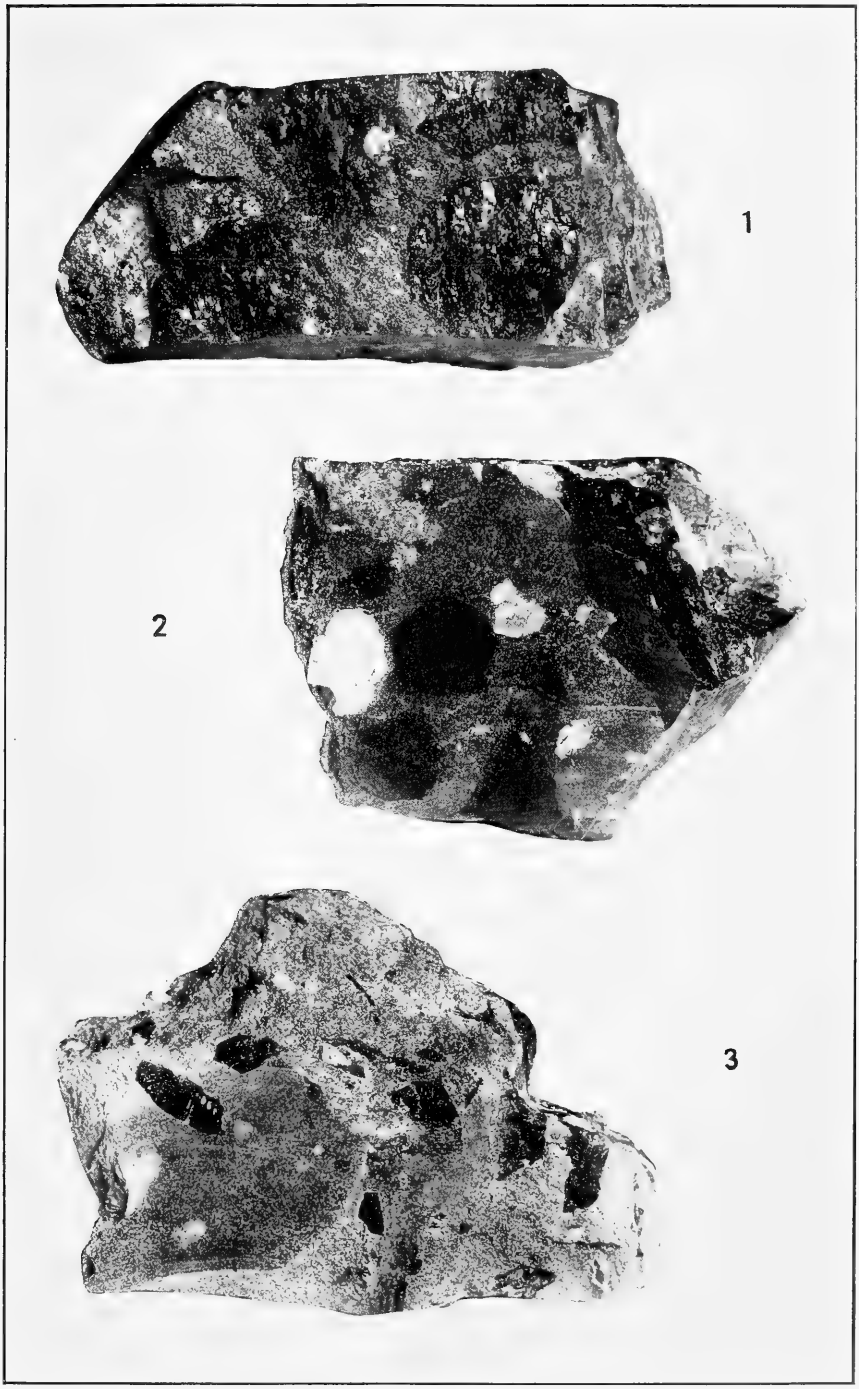
2

Horizon of glendonites and small concretions, Glendon, Hunter River.



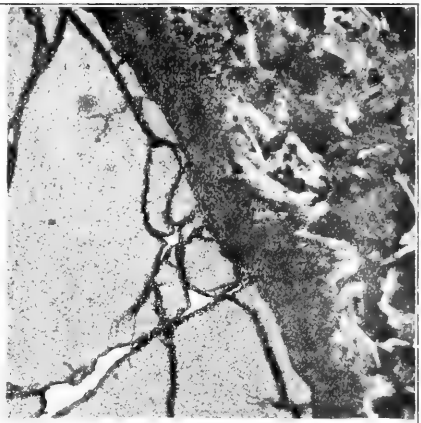
3
Concretion in shale at Glendon.

4
Large concretion showing system of joints.



1, 2.—Basalt, with inclusions, from dyke, Kelly's Point, Moruya District.
3.—Keratophyric dyke-rock from Lake Coila, Moruya District.

1



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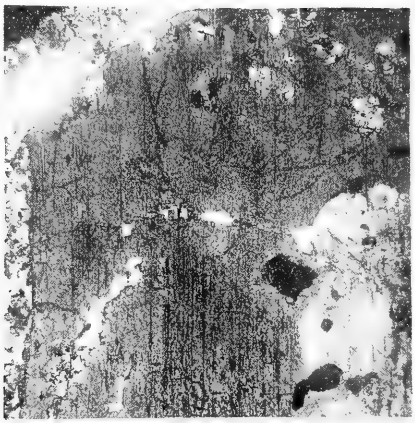

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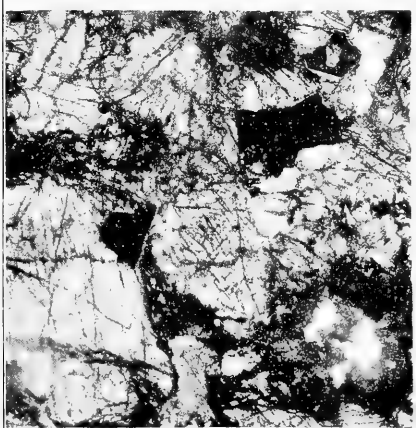


4.

5

NOTE ON THE STRUCTURAL AND TECTONIC GEOLOGY OF THE HUNTER VALLEY BETWEEN GRETA AND MUSWELLBROOK, WITH SPECIAL REFERENCE TO THE AGE OF THE DIASTROPHISM.

By H. G. Raggatt, B.Sc., Geological Survey of New South Wales, Department of Mines, Sydney.

(Published with the permission of the Under-Secretary for Mines.)

(Plate xi and two Text-figures.)

[Read 31st July, 1929.]

Introduction.

The geology of the Hunter River district has perennial interest for Australian geologists. The earlier investigators, such as C. S. Wilkinson and R. Etheridge, Jr., were chiefly concerned with the stratigraphy of the area and it was not until the publication of Sir Edgeworth David's classical memoir (1907) on the Hunter River coalfield that tectonics received much attention. In this memoir attention was drawn to certain features, which indicated that a noteworthy earth movement had commenced shortly after the deposition of the Muree beds. Since that time the term "late-Palaeozoic folding" has taken a prominent place in discussions on the structural and tectonic geology of a wide area, including in addition to the Permian, Carboniferous rocks to the north of the Hunter River and Triassic rocks to the south of it.

This preliminary statement is brought forward for the purpose of drawing attention to the bearing of newly-discovered facts on the problem, and to suggest a more critical examination of other evidence for late Palaeozoic folding in the Hunter River district.

Summary of Stratigraphy.

As the stratigraphy of the Permian beds will be frequently referred to in this note, the following summary of the subdivisions of this system as at present classified by the Geological Survey of New South Wales is given:

Upper Coal-Measure Series.
- (*a*) Upper or Newcastle Division.
- (*b*) Lower or Tomago Division.

Upper Marine Series.
- (*a*) Crinoidal Stage.
- (*b*) Muree Stage.
- (*c*) Branxton Stage. *Fenestella* shale horizon about 1,550 feet from base.

Lower or Greta Coal-Measure Series.

Lower Marine Series.
- (*a*) Farley Stage.
- (*b*) Lochinvar Stage.

Structural Geology.

The geological survey of the area has progressed sufficiently to enable the principal structures in the Permian rocks to be classified. Broadly speaking, the area is divisible into the three geographical divisions of Eastern, Central and Western. The Eastern section consists of the Lochinvar Dome and associated structures and is occupied largely by Upper Marine rocks. The Western section consists of the Muswellbrook structure also largely developed in rocks of Upper Marine age. Separating the two is an area occupied by Upper Coal-Measures which is broadly synclinal, but regarding the detailed structure of which little is known.

Two groups of structures are present within the area. The first group consists of folds, some of which are closed, and faults which, so far as is known at present (with possibly one exception), are normal. The axes of the folds (major axes of the domes) and the strike of the faults are approximately meridional. The second series of structures has an approximately north-westerly trend.

The major folds of the first group comprise: Lochinvar dome, Belford dome, Sedgefield dome, Darlington dome, Loder dome, Singleton syncline, Muswellbrook dome and Camberwell anticline.

The associated normal faults are: Matthew's Gap fault, Mundawah Creek fault, Mount Thorley fault, St. Hillier's Fault? and Skellater Fault?

The St. Hillier's and Skellater faults have been determined by M. Morrison as important structures, but further work is necessary to indicate to which type they belong and to show their relationships to the folding.

In addition to the structures enumerated above, there are many small folds and faults which are not indicated on the accompanying map (Plate xi). In the Coal-Measures at Ravensworth and in the vicinity of Jerry's Plains, for instance, folds which pitch to the south are developed. It is difficult to delimit these accurately because of the absence of key beds and the scarcity of outcrops.

Some explanation of the nomenclature of the faults is required here. The Elderslee fault, as originally drawn by Professor David, truncated the Lachnagar fault. Later he considered that the northern end of the Elderslee fault was continuous with the Lachnagar fault (see Browne, 1926, p. 261). The recent work of the Geological Survey of New South Wales (and, independently, that of K. J. F. Branch) has confirmed this.

As Sir Edgeworth David used the name "Elderslee" primarily for that section of the fault which is now shown to be part of the overthrust Lachnagar fault, it has been considered advisable to change the name of the normal fault formerly regarded as the southerly extension of the Elderslee fault to Matthew's Gap fault, a name which has been used freely by Sir Edgeworth David in discussing it and which seems to be singularly appropriate.

The Lachnagar fault is re-defined as that section of the Great Boundary fault (Hunter overthrust) which extends from Eelah to the Webber's Creek fault. The latter fault, as worked out by A. B. Walkom (1913), had definite limits but, as it is now known to be part of the overthrust fault system, it will probably be necessary to fix an arbitrary limit for it in an easterly direction.

The Mundawah Creek fault is the same as that which has formerly been regarded as the northern extension of the Greta fault.

The chief structure of the second group is the large overthrust fault which, for the greatest part of its length, constitutes the boundary between the Permian

and Carboniferous rocks. For this reason the fault is known to the Geological Survey of New South Wales as the Great Boundary fault (*Ann Rept. Dept. Mines N.S.W.*, 1928, p. 115). G. D. Osborne (1928, p. 580) has given this fault the name of Hunter overthrust.

Faults which trend parallel to the overthrust and which appear to be related to it are the Greta and Radfordslee faults.

The present state of our knowledge of the overthrust fault system is the result of a good deal of field work by several geologists.

In 1914 (pp. 194-5) J. E. Carne and M. Morrison noted and mapped a large fault to the north-east of Muswellbrook. Professor David (1914, p. 570) also drew attention to this fault and, correlating it with those noted in his previous surveys in the vicinity of Branxton and Greta, stated that he considered the geosyncline of the area now known as the Main Coal Province to be bounded on the north-east by "a heavy overthrust fault".

Since 1922 a field party under M. Morrison has been engaged in detailed survey work in the Hunter Valley and, over practically the same period, G. D. Osborne has been engaged in geological work in the Carboniferous. W. R. Browne has also conducted work at Gosforth and in the vicinity of Scone.

The result of all this investigation has been to confirm Professor David's views as to the existence and extent of the overthrust fault and to work out in considerable detail its structural and tectonic relationships, and its economic effects.

The Great Boundary fault (Hunter overthrust) extends from Eelah to a point two and a half miles south-east from Scone, a distance of about 65 miles. The general trend is north-west. From its commencement near Eelah the fault (Lachnagar section) trends west-north-west to the Hunter River, swings west to Elderslee and then follows alternately the approximate directions of north-north-west and west-south-west, at the same time assuming a more marked generally northerly trend to its termination near Scone.

From Scone to Glendon Brook the fault surface is uninterrupted, but at the latter locality it is separable into the two sections known as the Lachnagar and Webber's Creek faults. The fact that the thrust has thus expressed itself in two fractures supports the view of E. C. Andrews (1928, p. 95) that other sub-parallel faults may be expected to the north-east. It also indicates that, in section as well as in plan, the fault surface is convex to the south-west and that the dips measured at the outcrop would be found gradually to decrease if the fault surface could be followed towards the direction from which the thrust came. The angle of dip of the overthrust as measured by the Geological Survey of New South Wales appears to vary between fifteen and thirty degrees. The measurement of dip is complicated by the fact that both rock systems adjoining the fault have been folded prior to overthrusting and observations of dips in the beds close to the thrust surface may have only local significance.

The author's view concerning the origin of the Greta and Radfordslee faults is given on page 276 and need not be further discussed here.

For a fault of its magnitude the Hunter overthrust shows very little metamorphism or subsidiary fracturing adjacent to its outcrop, and there is a rather marked absence of folding in the beds in front of the thrust. Modification of pre-existing structures has taken place and in some localities the Permian beds have been thrown into folds the axes of which are parallel to the overthrust. The Hebden syncline is a fold of this kind and similar structures appear to be present to the north-east of Muswellbrook.

Tectonic Geology.

A comprehensive survey of the area seems to the author to indicate most clearly the sequence of events in the orogenic movements affecting it as follows:

1. (*a*) Folding due to pressure from the east or west or both, followed closely by (*b*) normal meridional faulting.
2. Overthrusting from the north-east with the production of folds in the Permian rocks and the formation of domes and faults by modification of the folds produced by the first movement.

As field work proceeds it becomes more and more evident that the result of the first movement was to produce folds with their axes arranged meridionally, generally pitching to the south. It seems very likely that the domes were originally folds of this type, because, so far as our knowledge goes at present, the structures in the Permian beds away from the influence of the overthrust fault are, as described above, folds with a southerly pitch. Further, the few folds which can be shown definitely to be related to the overthrust are arranged in a north-westerly direction.

A glance at the map will show the marked parallelism which exists between the axes of the folds and the normal faults. In addition it will be noted that the Mt. Thorley fault passes northerly into the Camberwell anticline. These two facts, taken together, appear to make it quite clear that the same earth movement produced both sets of structures. The arrangement of the faults with regard to the folds suggests that the faults represent the relief of tension on the downward sagging sides of the anticlines with which they are associated. The Matthew's Gap and Mt. Thorley faults are so related to the Lochinvar and Loder Domes respectively. While the relationship between the Sedgefield Dome and the Mundawah Creek fault is not so clear, because of the proximity of the Great Boundary fault, at least the fault is shown to cut off the Muree beds and to be, therefore, of later date than the folding.

Sufficient field work has not yet been done to show in what way the St. Hillier's and Skellater faults are related to the folding.

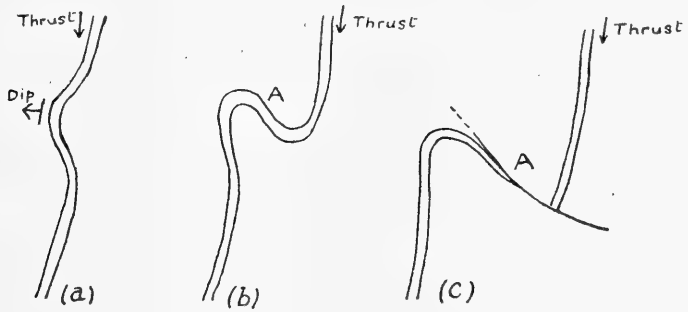
The Lochinvar dome (see Browne, 1926, 251-3, for use of terms "dome" and "anticline") appears to have been modified by thrusting from the north-east. This thrust, by compression in a direction nearly parallel to the axis of the anticline, has probably induced the subsidiary anticline and syncline oriented in a north-west–south-east direction near Branxton, and the related Greta fault. Examinations made in the Rothbury colliery workings show very plainly how the coal-measures have been dragged round in sympathy with the Muree beds. It is probable that the structure would be better represented here by considering this section of the Greta Coal-Measures as joined by a steeply dipping, sheared limb to the small area shown against the fault about half-way between Greta and Branxton. About Greta itself the outcrop seems definitely to have been broken.

The bulge in the outcrop of the Greta Coal-Measures at Pelaw Main (see David, 1907, map; or Mineral Industry of N.S.W., 1928, Pl. xix) was probably formed at the same time. With a continuation of pressure and immediately prior to the commencement of overriding of the Permian rocks by the Carboniferous, the Radfordslee fault was probably formed.

It is necessary to make it quite clear that a Lochinvar anticline existed prior to overthrusting and had been subjected to peneplanation. When overthrusting occurred, a large component of thrust was directed parallel to the strike of the

sediments (considering the western limits only). The sediments under these conditions would be most likely to warp in the direction of dip (Text-fig. 1, *b*). Continuation of thrust in a suitable direction* relative to the strike of the beds, facilitated perhaps by lateral movement on the overthrust in an easterly or south-easterly direction, would tend to produce the structure shown in Text-figure 1, *b*, with tension at A. The final result of continued general compression would be increased local tension and rupture at A (Text-fig. 1, *c*). That the Muree beds appear not to have fractured whilst the Greta Coal Measures have done so, is probably largely a question of relative competence.

Some difficulties which prevent a clear understanding of the Radfordslee fault may be pointed out. In portion 114, Parish of Branxton, County of Northumberland, the Greta Coal Measures dip at 63 degrees in a direction north



Text-fig. 1.

thirty degrees east, whereas about a mile and a half easterly from this locality they appear to dip south at 65 degrees. The dips at intermediate points are steep and no cross faults could be detected which would naturally be expected to be present as an expression of the relief of torsion which the observed dips imply to exist. The fault is very close to the overthrust and may, in reality, represent a complex series of fractures, along surfaces parallel to it.

It might also be added that outcrops in the vicinity of the fault are largely obscured by alluvium of the Hunter River.

This view seems to be supported by the marked similarity which exists between the Lochinvar and Sedgefield domes. In the latter structure the subsidiary folds are oriented somewhat more northerly than in the Lochinvar dome, a feature which, apparently, is due to the fact that the overthrust fault itself has a north-north-west–south-south-east trend near Sedgefield, whereas near Greta and Branxton its trend is approximately east and west.

To the north of the Sedgefield dome the Mundawah Creek fault, which intersects the dome, is cut off by the Great Boundary fault, indicating quite clearly their relative ages.

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* It is obvious that the angle between the direction of thrust and the strike of the sediments could have been such as to produce structures oriented NE-SW instead of NW-SE as they actually are.

The final result of the two periods of crustal activity has been to produce two groups of analogous structures. One group consists of the Lochinvar dome, with its modifications as described above, and the Belford dome; the other consists of the Sedgefield dome similarly diversified and the Darlington dome.

G. D. Osborne (1928, 587) has also concluded that the folds and normal faults in the Carboniferous rocks in the areas examined by him were formed during the same period of diastrophism and that the overthrusting was much later.

Two great diastrophic movements have thus been described for both Permian and Carboniferous rocks. The evidence appears against the conclusion (E. C. Andrews, 1928, p. 231) that the major folds in the Permian represent the effects in decreasing intensity from east to west of the same force which produced the overthrusting.

Age of Earth Movements.

It is well established that a great fold movement occurred in certain parts of Eastern Australia during late Palaeozoic time. In the New England district of New South Wales, as E. C. Andrews has shown (1908, p. 11), the movement was accompanied by the intrusion of granites. But between this area and the Hunter River Valley there is a large tract of country about which little is known.

In correlating the folds of the Hunter River coalfield with this movement no new evidence has been brought forward to add to what Professor David has said concerning earth movements in late- and post-Palaeozoic time. His conclusions (1907, 338-9) briefly were that "considerable local deformation of the earth's crust took place during Permo-Carboniferous time . . . ." and "in the interval between the close of the Permo-Carboniferous Period and the beginning of the Triassic Period, the deformation had progressed so far that one of the chief domes or anticlines—the Lochinvar Anticline—had been elevated fully from five thousand to six thousand feet, and that amount of strata had been removed by denudation from it, so as to reduce the anticline to a state of a peneplain, before the first of the Triassic rocks were laid down upon it".

The above statement is based chiefly upon the fact that there is an overlap of Triassic on to Upper Marine rocks near Ællalong. On the same structure—the Lochinvar dome—there is also evidence, however, of post-Triassic movement.

Mr. Leo. J. Jones, Geological Surveyor, has recently made an examination of the Matthew's Gap area and has measured a number of detailed sections across the beds there exposed. Mr. Jones has kindly allowed me to examine these sections and has discussed them with me. The sections reveal that there is a considerable amount of thinning below the Muree beds as well as above them, and that there is a gradually decreasing dip from east to west across the sections. There is not, in fact, much more marked difference in the amounts of dip as measured in the Triassic and Muree beds than there is between, say, the latter beds and the Greta Coal-Measures.

It is clear from this that the Triassic and Permian have been involved in the same diastrophism. Obviously it will be necessary in the future to reconcile the evidence available at Ællalong with that at Matthew's Gap and elsewhere.

An earth movement of the magnitude mentioned by Professor David might also be expected to have produced some noticeable differences in the dips of Triassic and Permian beds or to have produced some erosion features in areas

adjoining the Lochinvar dome. The existence near Broke, only eight miles north-westerly from Matthew's Gap, of a thickness of Upper Coal-Measure rocks quite comparable with the maximum thickness recorded for these beds at any other locality in New South Wales (Morrison and Raggatt, 1928), overlain conformably by Triassic sandstones, is hard to reconcile with the view that the Lochinvar dome is a product only of late-Palaeozoic folding.

A study of the structure lines at different stratigraphical intervals in the Permian over the area included in the map (Plate xi) is instructive. This reveals that the structures defined by the Greta Coal-Measures, the Fenestella shales, the Muree beds and the base of the Upper Coal-Measures are parallel. The existence of folds and faults in Upper Coal-Measure rocks which are to be correlated with the first period of marked diastrophism affecting the Permian, also shows that the folding in large measure post-dated the deposition of the Upper Coal-Measures. This applies to nearly all the structures enumerated on page 274 as well as folds in the vicinity of Ravensworth and Jerry's Plains.

The geological mapping of the Coal-Measure–Trias boundary from Pokolbin to Denman revealed no discrepancy in dip between the beds above and below the junction and no disconformities due to contemporaneous erosion. Furthermore, where folds could be traced in the Permian beds beneath the Trias, the latter had also participated in the folding. The Wollombi Brook, for instance, follows a structural anticline (with a southerly pitch) for some distance south of Broke, which equally involves the Permian and the Triassic. Indeed, working outwards (i.e. to the south and west) from the Loder dome, as defined by the Muree beds, the dips gradually lessen, and one is forced to conclude that the anticline referred to and the Loder dome are cognate structures.

The inference has been drawn, that because Permian beds have been observed to be folded and faulted in one place and Triassic beds to be flat or gently folded in another place not far from the first, the former have experienced pressures which the latter have not (Osborne, 1928, p. 584). On the contrary the evidence shows that, except at Ællalong, wherever we can observe the two together they appear to have participated in the same orogeny.

In 1925 M. Morrison (p. 127) recorded the remarkable prevalence of igneous rocks, chiefly in the form of sills, to the south of Muswellbrook. Since that time several additional areas of igneous rock have been noted, chiefly in the western half of the area. The principal sills, the dimensions of which are given in the Annual Report of the Department of Mines for 1928, are: (1) Savoy, (2) Plashett, (3) Carrington, (4) Fordwich. These are shown on the map accompanying this paper. The petrology of the sills has not yet been worked out, but the dominant rock in each approximates teschenite and in general closely resembles the rock of the alkaline basic intrusion at Prospect, which intrudes the Wianamatta shale of the Sydney district and to which a Tertiary age is assigned. The rock of the Fordwich sill is an olivine-teschenite, the chemical composition of which is given in the Annual Report of the Department of Mines (N.S.W.) for 1928.

Three small basalt plugs have also been noted (one north of Liddell and two at Doyle's Creek) in addition to basalt cappings on the Triassic plateau.

On petrological grounds the Tertiary age of all these rocks may be regarded as well established.

The sills have been mapped in considerable detail, but this is largely lost in the small scale map, herewith. The disposition of the Savoy, Plashett and

Carrington sills, in relation to the Muswellbrook dome suggests that the intrusion of the igneous rocks is related to the formation of the structure. There is nothing, perhaps, particularly suggestive about the Fordwich and Carrington sills except that, as is characteristic of phacolites, their long diameters are parallel to the axes of folding (Harker, 1909, p. 78). The Savoy sill, however, is at the heart of an anticline and the Plashett sill is distinctly infolded with the intruded coal measures as the section (Text-fig. 2) shows.

Text-fig. 2.—Section across the Plashett sill (and the south end of Muswellbrook dome) showing its suggested phacolitic origin. A, Upper Coal Measures; B, Upper Marine Series; C, alkaline dolerite.

There can be little doubt from the field evidence that the intrusion of the Plashett sill took place concurrently with the local folding of the beds. The only question here at issue is whether this folding was the same as that which produced the Muswellbrook dome or not. The presence of the Savoy and Carrington sills and their disposition with regard to the same structure appear to suggest that it was.

On certain aspects of this problem there is general agreement. Professor Browne (1924, 139-141) shows the Wingen fault to be Tertiary or younger in age. While his later tentative correlation of the Lachnagar and Wingen faults has proved incorrect (see Osborne, 1928, 595), the one being overthrust and the other normal, his conclusion (1926, p. 260) regarding the pre-Kosciusko uplift age of the Lachnagar fault is based on indisputable evidence. Osborne (1928, p. 587) considers it probable that peneplanation took place in the interval between the normal faulting and overthrusting. He places (p. 584) the age of the overthrusting as post-Palaeozoic and pre-Pliocene, reserving a more exact determination for later discussion.

In this preliminary statement three lines of evidence have been considered and certain deductions made, which may be summarized as follows:

(1) The structures taken in conjunction with the stratigraphy of the Permian beds show that the folding to a great extent post-dated the deposition of the Upper Coal-Measure series.

(2) A consideration of a large section of the surface between Triassic and Permian rocks reveals no marked pre-Mesozoic deformation or erosion. The structures in the two systems appear to be related and the inference is that the folding was largely post-Triassic.

(3) The occurrence of igneous rocks of Tertiary age infolded with Permian beds suggests a phacolitic origin for some of them and the probable Tertiary age of the Muswellbrook dome in part, at least.

All these lines of investigation point to the conclusion that an orogenic movement took place in Tertiary time which was, to a considerable extent, responsible for the formation of the meridionally arranged structures such as the Lochinvar dome and the Muswellbrook structure.

The evidence for late-Palaeozoic folding requires critical examination in view of the new facts available, especially in relation to the Lochinvar dome. It will then become a problem for the future to try to ascertain the relative importance to be assigned to late-Palaeozoic and Tertiary movements in producing the structures in the Permian rocks of the Hunter Valley.

Notes on the Geological Map (Plate xi).

With the addition of dips and some very slight modification the geological map (Plate xi) accompanying this paper is a combination of the two maps published with Mr. Morrison's statement on the Singleton-Muswellbrook coalfield survey in the Annual Report of the Department of Mines for 1928. The author's connection with the survey of the area is set out in that statement.

The Fenestella shales have been omitted from this map as in that on which it is based, for the sake of clearness. They outcrop within the Muree beds on the Belford dome and along the western limb of the Lochinvar dome.

The two areas of basalt shown surrounded by Triassic rocks (near Doyle's Creek) are extrusive, the remainder are intrusive.

The structure of a small area adjoining the Hunter River to the north-north-east of Branxton is somewhat obscure. Detailed mapping is necessary near Muswellbrook for the subdivision of the Upper Marine Series into stages. Additional areas of igneous rock may be discovered and some faults are suspected which have not yet been indicated on a map.

G. D. Osborne's maps of various areas of Carboniferous rocks adjoin this map along the overthrust fault. W. R. Browne's Gosforth map joins at the north-east corner, and the area is partly covered by Professor David's map which extends from Branxton to the coast. To the south and south-east Leo. J. Jones has recently completed a geological survey. Some of the results of his survey are included in Plate xix in the "Mineral Industry of New South Wales" recently published by the Department of Mines.

Acknowledgments.

The author is indebted to Mr. E. C. Andrews, Government Geologist of New South Wales, for much assistance and advice in connection with the preparation of this paper, and to Mr. M. Morrison, Geological Surveyor, who has kindly permitted the use of information gained under his supervision.

The author's thanks are also due to Assistant-Professor W. R. Browne for his constant interest in the work and helpful discussion in the field and in the laboratory. Mr. Leo. J. Jones, Geological Surveyor, as stated elsewhere, has materially assisted in the preparation of the paper and the author has profited by many discussions with Dr. G. D. Osborne.

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PLATE XI.

Geological Map of the Hunter River Valley between Greta and Muswellbrook.

NOTES ON AUSTRALIAN DIPTERA. XX.

By J. R. Malloch.
(*Communicated by I. M. Mackerras.*)

(Thirty-four Text-figures.)

[Read 31st July, 1929.]

This paper contains notes on Calyptrate Diptera only and is intended as a final contribution on the genus *Rutilia*.

Family **Muscidae.**

Subfamily Phaoniinae.

Helina howei Malloch.

A metallic dark green species, with grey dusted thorax, black legs, cross-veins of wings conspicuously infuscated, the apical portions of wings slightly so, the calyptrae white, and halteres fuscous.

A female specimen before me differs from the type in being much larger (7:5 mm.), but otherwise agrees in all respects with it. This specimen has the fore tibiae present and armed with two posterior bristles. The type specimen lacks the fore legs.

Locality.—Lord Howe Is.: Mt. Gower, 19.1.1922 (A. R. McCulloch). Australian Museum.

The type specimen belongs to the British Museum of Natural History.

Family **Calliphoridae.**

Subfamily Rhiniinae.

Chlororhinia viridis Townsend.

Three examples of this species in very much abraded condition are amongst the material submitted to me from the Australian Museum.

Locality.—Exeter, N.S.W., March, 1927 (A. H. Murray).

I have previously recorded this species from New South Wales and Queensland.

Metallea illingworthi Aldrich.

Three specimens of this species submitted by the Australian Museum from the following localities: Galston Gorge, Berowra, nr. Hawkesbury River, N.S.W., February, 1927 (T. G. Campbell); Norton's Basin, Nepean River, 17.10.1920 (A. Musgrave).

Family **Tachinidae.**

The descriptions and records presented herein are mainly of species recently received and the data presented in the discussions of same are intended to convey some of the more important and frequently overlooked characters of these to the printed page for the convenience of Australian students of these flies. I have made

no effort to obtain a large collection of the species, so have rather a paucity of genera available, none of them of remarkable characteristics, except possibly the *Rutilia* group, *Amenia*, or *Microtropeza*. Many of the species belong to genera which have a very wide distribution, and some of them of more limited dispersal belong to genera that occur in the Orient and the intervening islands of the Pacific and Indian Oceans.

It is impracticable at this time to publish a key to the genera recorded from Australia, as some of the species placed in certain genera very probably do not belong to these genera. Consequently a complete generic synopsis must await a fuller knowledge of the species involved.

Tribe **Phasiini**.

Genus Hyalomyia Robineau-Desvoidy.

In a recent paper of this series I summarized my knowledge of the Australian species of this genus, describing four as new. Directly after sending the manuscript to Dr. Mackerras I received from him a shipment of flies which contained several new species of Tachinidae, dealt with in the following pages, including two belonging to *Hyalomyia*. One of the latter lacks the abdomen and, though it probably belongs to an undescribed species, I am leaving it aside pending receipt of better specimens; the other specimen is in good condition and is described below.

Hyalomyia costalis, n. sp.

Male.—Black. Face yellowish below and on sides, obscured by whitish dust, as are the other portions of head; antennae black; palpi testaceous; frontal hairs, those on facial ridges and vibrissal region, and the postocular ciliae, black, occipital and genal hairs white. Thorax black, densely pale grey dusted, mesonotum with four black vittae, the submedian pair appearing as a broad central stripe, except as seen from behind when the intervening space is quite evidently brownish-yellow dusted in front of suture, sublateral vittae narrow, interrupted at suture, narrowed behind and not attaining hind margin of mesonotum; scutellum entirely black, slightly shining. Abdomen shining black, with slight brown tinge basally, entirely yellowish dusted below, more greyish dusted on sides anteriorly, the colour of dust changing apically to yellow, fourth tergite densely yellow dusted, less so centrally and anteriorly in middle where it is shining, fifth tergite entirely densely yellow dusted. Legs black. Wings greyish hyaline, quite conspicuously brownish or fuscous along costa to apex of first vein, and with a faint pale brown cloud over the inner cross-vein. Calyptrae greyish, lower one with a large brownish basal cloud. Halteres brownish-yellow.

Frons linear above, orbits setulose on anterior third, with short fine hairs almost to anterior ocellus, and a few hairs laterad of the anterior setulae; ocellars undeveloped; antennae hardly more than half the length of face, third segment hardly longer than second; mouth margin slightly produced, almost on a level with lower margin of eye; parafacial above about as wide as third antennal segment and half as wide as height of cheek; palpi long and slender. Thorax with quite dense black hairs, one very poorly differentiated pair of dorsocentrals in front of suture, and one posterior marginal pair of strong and one anterior pair of weak dorsocentrals in front of scutellum, the posterior acrostichals well developed; sternopleurals 1 + 1; mesopleural hairs not flattened. Abdomen longer than thorax, and about one and a half times as long as wide, basal visible tergite

longest, the others, except fifth, subequal in length. Legs normal, trochanters and bases of fore and mid femora pale haired, hind femora entirely black haired. Inner cross-vein of wing more than one-third from apex of discal cell; bend of fourth vein evenly rounded.

Length, 7 mm.

Type, Woodford, N.S.W., 15.11.1925 (Nicholson).

This species will not find a place in my key already printed, as it is intermediate in length between the two segregates. It is related to *nigrisquama*, having the apical scutellar bristles at tip, but the head is different in shape from that of that species.

In a paper received by me after my catalogue of this family had been sent to the press I find a description by C. H. Curran of *Alophora aureiventris*, a new species from Queensland (*Bull. Ent. Res.*, 18, pt. 2, 1927, 165). If this species is referable to *Hyalomyia*, and I can see no reason why it should not be, it differs from any other known to me in the male sex by the colour of the wings, which are "blackish, with pale streaks in the costal cell, along the third and fifth veins, and in the apical cell, the veins more or less yellow basally". The dorsum of the thorax also appears to be distinctively marked, having "four rather broad, subshining black vittae, and with a large, transverse, golden pollinose presutural spot which is triangularly produced in the middle almost to the suture". The abdomen of the male is golden pollinose dorsally, with sometimes the apical segment and part of the preceding one darkened, and an obscure median vitta. The female has the wings hyaline, and the abdomen black, the second and third segments with broad, interrupted, yellowish pollinose basal fasciae, the fourth segment usually wholly yellowish pollinose, and the venter grey as in the male. This is as large a species as *costalis*, and evidently with much broader wings in the male.

Reared from the hemipteron *Dysdercus sidae*.

In the same paper there are two other Australian species of the family described, which were not included in my catalogue when originally submitted for publication; these were subsequently added.

Hyalomyia sp.

The species which I mention above as being in too poor condition to describe is about the same length as *costalis*, but has the wings entirely fuscous, darker costally, and with a hyaline streak along the costal margin of third vein, the thorax with four dark vittae, the central pair ceasing about midway between suture and the hind margin. Lack of the abdomen prevents me from describing the species fully, but the above may suffice to identify it should anyone have perfect specimens.

Tribe **Ameniini**.

Genus Amenia Robineau-Desvoidy.

I have previously presented a key to the known species of this genus in this series of papers, and now describe a new species which is quite different in general appearance from the others. No previously recognized species has the abdomen densely greyish-white dusted and with conspicuous black spots, all being brilliant metallic blue or green, with or without darker areas, and with conspicuous white dusted spots on thorax and abdomen. This distinction in coloration alone is sufficient to separate the new species from the others.

I append below records of two of the old species.

AMENIA PARVA Schiner.

Two specimens, Norton's Basin, Nepean R., 17.10.1920 (Musgrave), and French's Forest, N. Sydney, N.S.W., 12.3.1923 (T. G. Campbell). Australian Museum.

AMENIA LEONINA (Fabricius).

Two females, Gundamaian, Port Hacking, N.S.W., 12.3.1927 (T. G. Campbell), and Deep Creek, 20 miles from Kingscote, Kangaroo Is., S.A. (E. Troughton). Australian Museum.

AMENIA NIGROMACULATA, n. sp.

Male.—Head bright orange-yellow, occiput black except on sides below, ocellar triangle black, basal two antennal segments fuscous, proboscis and all cephalic hairs black, aristae fuscous at bases, yellow apically. Thorax black, slightly bluish at edges of the white dorsal spots, mesonotum with two white dusted submedian vittae, but the specimen is greasy where the pin is inserted so that they appear to be broken at posterior side of the suture which may not be the case in perfect specimens, and in addition to these vittae there are three spots on each side of same nature, the one on humeral region largest, mesopleura and sternopleura each with a similar spot; spiracular coverings black. Abdomen with the first visible tergite deep black, the others densely coated with greyish-white dust, through which a green tinge shows from the underlying surface, second tergite with five deep black marks, a spot in centre, a small one on each side of that at the lateral curve, and a small mark on each of the lateral edges, third tergite with two additional spots, each about as large as the central one, situated between the latter and the small one on lateral curve, fourth tergite with a large central black apical mark which is subtriangular in shape, its apex broad. Legs black, femora purplish. Wings clear, infuscated at bases. Calyptrae and halteres fuscous.

Frons at narrowest point a little wider than third antennal segment, the latter about as long as distance from its apex to mouth margin and not two-thirds as long as height of cheek. Thorax with 2 or 3 + 4 well developed dorsocentral bristles, and about three pairs of presutural acrostichals; sternopleurals 2 + 1; scutellum with eight marginal bristles. Abdomen broadly ovate, two strong bristles on each of the black dorsal spots on tergites 2 and 3, and one on the spot at lateral curve. Legs normal. Wings as in *parva*.

Length, 9 mm.

Type, Perth, W.A., 1.11.1924 (Nicholson).

Submitted by Dr. I. M. Mackerras, and to be returned to him.

Tribe **Microtropezini.**

Genus MICROTROPEZA Macquart.

Up to the present time only one species has been included in this genus, but before me now there are four, two of which can be readily distinguished from the genotype by the yellow colour of the abdomen, but the other is not so readily separated. In essential characters they all agree, possessing the features considered by me as of generic import in my previous treatment of the genus in part xvii of this series of papers, as well as the series of short hairs on the upper half of the occiput between the postocular ciliae and the eye, and an exceptionally short costal section between the apices of second and third

wing veins (Text-figs. 1, 2), the last two characters not already mentioned by me. The four known species may be distinguished by means of the following key.

Key to the Species.

1. Abdomen black to castaneous in colour, distinctly shining, with the anterior margins of visible tergites 2 to 4 densely grey dusted, most broadly on 4, and on 3 and 4 with a central extension of the grey dust and a similar extension along lateral edges, so that each has a large deep black spot on each side of dorsal exposure .. 2
   Abdomen entirely ochreous, with a more or less evident central dark vitta on the basal two or three tergites, but never with deep black dorsal paired spots 3
2. Mesopleura largely yellow-haired, but with some strong black hairs on centre of disc; no conspicuous black mark on the extreme lateral incurved margins of tergites; fore tarsus of female but slightly widened (Text-fig. 3*b*) ..... *sinuata* Donovan
   Mesopleura entirely yellow-haired, without any black hairs on centre of disc; a conspicuous black mark on each lateral incurved margin of each tergite except the second; fore tarsus of female much widened (Text-fig. 3*a*) .. *latimana*, n. sp.
3. Visible tergites 3 and 4 ochreous, when seen from behind with dense uniform ochreous dust; tarsi with at least the apical segment fuscous; sternopleurals two in number (1 + 1) ..... *ochriventris*, n. sp.
   All visible tergites when seen from behind with dense grey dusting and a pair of large glossy ochreous spots on dorsum; tarsi entirely yellow; sternopleurals three in number (2 + 1) ..... *flavitarsis*, n. sp.

MICROTROPEZA LATIMANA, n. sp.

Female.—This species agrees so closely with *sinuata* that it may readily pass for it unless carefully examined. In general habitus and coloration the two species are strikingly alike, but the lack of any black hairs on centre of mesopleura, the presence of large black spots on lateral edges of the tergites, and the broad fore tarsi of the female, should distinguish this species from the genotype. It is also noteworthy that the large black submedian spots on the dorsum of abdomen extend the entire length of the tergites forming a complete serrate vitta on each side, the tarsi in *sinuata* are fuscous, but slightly yellowish on base of first segment, while in *latimana* the basal segment is almost all yellow and the fifth is entirely so. In my previous note on the genotype I did not mention the disparity in size of the tarsal claws of the sexes which I now illustrate for this species. I assume that this same distinction exists between the sexes of the other species, as the claws and pulvilli are long in the male of *flavitarsis* while in the females of *ochriventris* both are short. The fore tarsi of the female of *ochriventris* are the same as in *sinuata*. Except for the characters listed above the present species is similar to *sinuata*.

Length, 14 mm.

Type, Queensland, no other data. Australian Museum.

MICROTROPEZA SINUATA (Donovan).

I have before me three examples of this species from the following localities: 2 females, King George's Sound, W.A., and 1 male, Gayndah, Queensland (Masters). Australian Museum.

MICROTROPEZA OCHRIVENTRIS, n. sp.

Female.—Ochreous, shining, aristae dark brown, head orange-yellow, face white dusted, cheeks and parafacials yellow dusted, mesonotum infuscated on disc and slightly bronzy or coppery when seen from the side and above, with rather conspicuous white dust which divides the dark portion into four broad vittae, the

sublateral pair divided at suture, and none of the vittae extending clearly to hind margin; centre of each pleural sclerite rather noticeably white dusted, the small knob-like protuberance on pleura in front of base of wing covered with white pile. Second visible abdominal tergite more or less darkened and with noticeable white dust centrally, when seen from behind with dense pale yellow dust on front half and with two dark ochreous subtriangular spots behind, the abdomen otherwise ochreous and densely yellow dusted, not shining when seen from behind. Legs yellow, apical segment of each tarsus fuscous. Wings greyish hyaline, not yellow on basal half as in *sinuata*. Calyptrae and halteres ochreous yellow. Occiput with stout orange hairs.

Structurally similar to *sinuata*; parafacials quite strongly haired; cheek about two-thirds as high as eye. Thorax not so strongly bristled as in *sinuata*; presutural acrostichals two pairs. Abdomen with bristles weaker than in *sinuata*, especially on sides of fourth visible tergite and on apices of sternites, the fourth tergite of female not so pronouncedly emarginate at apex as in that species. Legs and wings as in *sinuata*.

Length, 11-13 mm.

Type and two paratypes, Allyn Range, Barrington Tops, N.S.W., February, 1925, on *Leptospermum* (Sydney University Zool. Exped.).

Submitted by Dr. I. M. Mackerras, to whom the species will be returned.

Microtropeza flavitarsis, n. sp.

Male.—Similar in general coloration to the preceding species, differing as stated below. It must be noted that I have only a male of this species and females of the preceding one, and there may be sexual differences in the species which, under the circumstances, I note as of specific significance.

The frontal orbits are shining and undusted in *ochriventris*, but in *flavitarsis* they, as well as the face and cheeks, are greyish-white dusted. The mesonotum lacks the coppery lustre of the preceding species, and while in *ochriventris* the submedian dark vittae are evidently fused anteriorly in front of the suture when seen from the side and behind, in the present species these vittae are separated by a stripe of grey dust. As in *ochriventris* the first and second tergites are dark centrally, but here the second has a quite noticeable black central vitta and there are traces of a dark line on third, the large glossy, ochreous spots on the tergites are similar in form and size to the black spots on the abdomen of *sinuata*, and they do not extend to the extreme lateral edges of the tergites. Legs entirely yellow. Wings quite conspicuously yellow at bases as in *sinuata* and *latimana*. Calyptrae and halteres yellow.

Frons at vertex fully one-fifth of the head width, without forwardly directed supraorbitals; second segment of arista about three times as long as thick; third antennal segment subequal to second. Thorax with bristles as in *sinuata*; sternopleurals 2 + 1. Abdomen robust, second visible tergite with about eight closely placed bristles on central portion of apical margin, third tergite with a complete series at apex, fourth with rather numerous bristles laterally, the bristles of transverse series subapical centrally, the tergite emarginate at apex in middle; sternites 2 to 4 strongly bristled at apices. Legs as in *sinuata*, fore tarsal claws and pulvilli long. Wings normal.

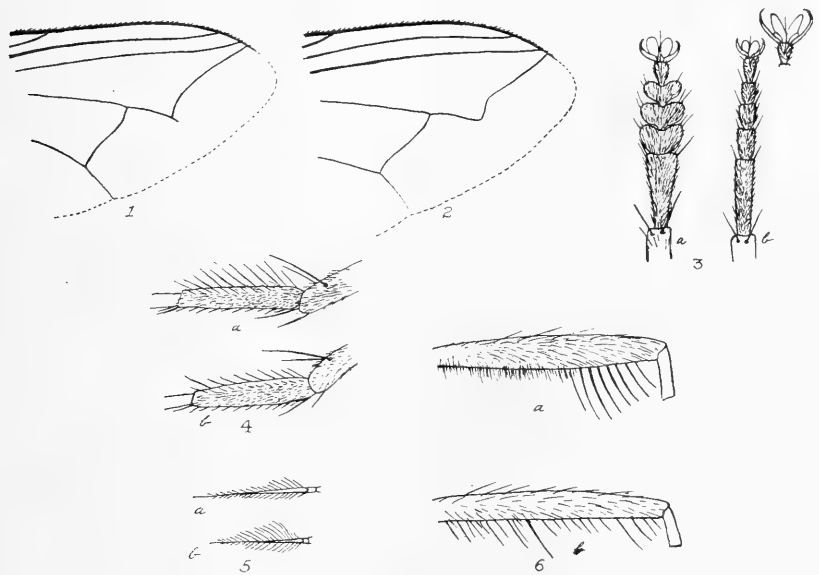
Length, 12·5 mm.

Type, Tasmania, no other data. Australian Museum.

Tribe **Cylindromyiini.**

Genus CYLINDROMYIA Meigen.

This genus is better known as *Ocyptera* Latreille, and under that generic name five Australian species have been associated, four of which I included in *Ocyptcropsis* Townsend in my recently published catalogue of the Australian Tachinidae. A careful scrutiny of the descriptions of these species indicates the probability of there being but one species represented by the names *flavifrons* Macquart and *bimacula* Walker, and *bicolor* Bigot is very similar. All three of these descriptions indicate species with the abdomen bicoloured, black and red,



Text-fig. 1.—*Microtropeza sinuata*, apex of wing.
Text-fig. 2.—*Microtropeza ochriventris*, apex of wing.
Text-fig. 3*a*.—*Microtropeza latimana*, fore tarsus of female from above.
Text-fig. 3*b*.—*Microtropeza sinuata*, fore tarsus of female from above, and apical segment of fore tarsus of male.
Text-fig. 4*a*.—*Prodiaphania georgei*, hind metatarsus of male from the side.
Text-fig. 4*b*.—*Prodiaphania testacea*, hind metatarsus of male from the side.
Text-fig. 5*a*.—*Prodiaphania georgei*, arista.
Text-fig. 5*b*.—*Prodiaphania testacea*, arista.
Text-fig. 6*a*.—*Prodiaphania testacea* ?, hind femur of male.
Text-fig. 6*b*.—*Prodiaphania testacea*, var. *claripennis*, hind femur of male.

the base and apex being black, and the central portion red with black dorsal spots. The fourth description, that of *tristis* Bigot, refers to an entirely black species which has white dusted bases to the abdominal tergites. Walker's species *diversa* does not belong to this genus in my opinion.

Both Walker and Macquart make particular mention of the yellow frons of the species they described, the latter author utilizing this character as the basis for his specific name, and despite the fact that the specimen now before me has the frontal orbits silvery instead of yellow, I consider it is the female of *flavifrons*.

It may be pertinent at this time to deal with the characters of the genus.

The name *Cylindromyia* was proposed by Meigen in 1803, *Ocyptera* by Latreille in 1805, the same species being the genotype in both cases. Meigen subsequently used Latreille's name for the genus in 1824, and with few exceptions this course was followed until 1910 when Coquillett adopted *Cylindromyia* and pointed out the synonymy. The most recent paper on the genus is that by Aldrich on the North American species and in this *Cylindromyia* is adopted and a full consideration of the synonymy presented (*Proc. U.S. Nat. Mus.*, art. 23, vol. 68, 1926, 1-27). The genus as accepted by Aldrich contains several generic concepts of Townsend, but he dealt with North American forms only and *Ocypteropsis* Townsend, being Australian, was not included. I now propose to sink this name also as a synonym of *Cylindromyia*.

I would define the genus as follows: Thorax chitinized on entire extent of its hind margin below base of abdomen and above hind coxae, presenting an almost vertical wall; pleural knob not outstanding, similar to that of typical Tachinidae; lower calypter long, rather narrow, and evenly rounded at apex, without an inner lobe, upper calypter short, almost a transverse strip; parafacials bare; facial ridges not setulose except for a short distance above vibrissae; palpi microscopic or totally lacking; proboscis slender, about as long as height of head, not geniculated except near base; prosternum and centre of propleura bare; fourth wing-vein connecting with third well before apex of latter, the tip of third curving forward towards costa and ending well before tip of wing.

The relationships of the genus have been the subject of various opinions, while the status of the group to which it belongs has been quite variously treated by different authors. In some cases the group has been accorded family rank, in others it has been reduced to a subfamily near Phasiinae, and in yet others treated merely as a tribe. Possibly this last definition is the proper one, but how many related genera there are at present known I am unable to state. *Cylindromyiella* Malloch, a Philippine genus, I would place in the tribe; it has the third wing-vein ending a little before apex of wing, the fourth ending as far behind apex and directly below apex of third, the first posterior cell open, and the venation like that of many Phaoniinae of the family Muscidae owing to the very slight forward curvature of the fourth vein. The proboscis is short and stout, and the palpi are large. Other genera that belong to the tribe are: *Penthiosoma* Townsend, a Philippine genus with venation similar to that of *Huttonobesseria* Curran, but the male has two forwardly directed bristles on each orbit; *Besseria* Robineau-Desvoidy, a European genus with closed first posterior cell of the wing as in *Cylindromyia*, but the third vein runs straight to the wing margin beyond its fusion with fourth instead of running obliquely forward into the costa, and the abdomen lacks strong dorsal bristles; *Oedamasoma* Townsend from North America is a synonym of *Besseria* in my opinion; *Euphania* Townsend is a European genus quite similar to *Penthiosoma*; *Ichneumonops* Townsend and *Polistiops* Townsend are rather bizarre forms which are doubtfully distinct from *Cylindromyia*. *Penthosia* van der Wulp and *Beskia* Brauer and Bergenstamm are closely related to *Xanthomelaena* van der Wulp and do not belong to the tribe as accepted by me.

I know of no other Australian genus of the group than *Cylindromyia*, but place *Huttonobesseria* Curran, erected for the reception of *Phania verecunda* Hutton from New Zealand in the same segregate. It has the first posterior cell of the wing open, ending almost in the wing tip, and the palpi well developed.

CYLINDROMYIA FLAVIFRONS (Macquart).

Female.—Black, head with dense white dust, interfrontalia fuscous, orbits silvery, antennae black, hairs on lower occiput white. Thorax with white dust, that on dorsum leaving two rather broad, and not very clearly defined black vittae, the lateral margins most densely dusted. Abdomen bright red, black on first tergite, apical two-thirds of fourth, and all of apical segments and the genitalia, a transverse mark on base of second tergite which extends narrowly backward in centre almost to middle of tergite, and an elongate spot on middle of third tergite; bases of tergites narrowly white dusted. Legs black. Wings greyish hyaline, yellow at bases. Calyptrae white. Halteres with fuscous knobs.

Frons at vertex about one-fourth of the head width, all verticals present, the outer pair shorter than the inner, ocellars and postocellars moderately long, equal; each orbit with two strong and one weak outer forwardly directed bristles; mouth margin slightly produced. Thorax as in *argentea* Coquillett; scutellars 6, apical pair short; sternopleurals 2. Abdomen with a pair of strong bristles at some distance from hind margin of tergites 2 to 4 inclusive, and a strong lateral bristle on those tergites and 5; genitalia tubular, slightly curved up at apex, with some short ventral bristles, and extending forward to level of base of fourth tergite. Legs normal; hind tibia with two anteroventral bristles. Angle of fourth wing vein with an appendage.

Male.—There are two males identified as this species in the collection of the United States National Museum, and apparently correctly so. Apart from the yellow-dusted frontal orbits and upper parafacials the thoracic dorsum shows four distinct black vittae which are not discernible in the female specimen described above.

I may be in error in associating these specimens as the sexes of one species, but their striking similarity leads me to do so despite the distinctions mentioned and their being from widely separated localities.

Length, 8 mm.

Localities: Female, Perth, W.A., November 15, 1924 (Nicholson); male, Sydney, N.S.W.

Tribe **Rutiliini.**

With the accession of more material I am enabled to present some more data on this tribe which may be of service to Australian students, though of course I am in no position to deal *in extenso* with the group.

It must be noted that the order in which the tribes appear in this paper is in no way to be accepted as indicative of their relationships.

Genus PRODIAPHANIA Townsend.

I have now in hand at least two species of this genus which are readily separable by structural characters. In my recently published catalogue of this family I included only one synonym of the genotype, *echinomides* Bigot, but Engel cites two others, *Rutilia analoga* Macquart, and *Senostoma variegata* Macquart. Without examining the type specimens of these two, it is impossible to verify this statement.

The new species may be distinguished from *testacea* as below:

A. Hind tibia without bristles on the posterodorsal surface except the one close to apex; hind tarsus of male with a series of bristles along the anterodorsal surface of basal segment which are longer than the diameter of that segment (Text-fig. 4*a*); arista short haired (Text-fig. 5*a*) ..... *georgei*, n. sp.

AA. Hind tibia with several quite prominent posterodorsal bristles on central portion; hind tarsus with shorter anterodorsal bristles on basal segment; arista longer haired (Text-fig. 5*b*) ..... *testacea* Macquart

PRODIAPHANIA GEORGEI, n. sp.

Male.—Similar in general coloration and structure to *testacea*, the scutellum largely testaceous, abdomen semipellucid brownish testaceous, with a broad dorsocentral black vitta, the dark sub-basal mark on the wing is pale brown, much paler than in typical *testacea* from the eastern section of Australia.

Structurally the species are similar, but the longer bristles on basal segment of hind tarsi, the lack of posterodorsal bristles on central portion of the hind tibia, and the shorter haired arista, sufficiently distinguish *georgei* from the genotype. The prosternum is bare laterad of the plate.

Length, 13-14 mm.

Type and one paratype, King George's Sound, W.A., no other data. Australian Museum.

PRODIAPHANIA TESTACEA (Macquart).

I am convinced that this species requires further elucidation, as I have before me two forms of the male which are distinguished by the armature of the hind femora, neither of which may be typical *testacea*. I give below a diagnosis of these forms and assign a new varietal name to one of them; the other may not be typical *testacea* either, as the females I accept as that form have the armature of the hind femur as in *georgei* and the variety *claripennis*.

A. Wing with a conspicuous dark brown mark close to base; hind femur with some long bristles on apical third on anteroventral surface, with fine hairs and no bristles on basal two-thirds (Text-fig. 6*a*) ..... *testacea* (Macquart)

AA. Wing without a dark mark close to base; hind femur as in *georgei*, with irregular bristles on the anteroventral surface, the longest near the middle, and again near apex (Text-fig. 6*b*) ..... var. *claripennis*, n.

var. TESTACEA (Macquart).

Females before me which I assign here, and which agree with available descriptions, have the anteroventral series of bristles on the hind femur as in *georgei*.

Localities.—Sunnybank, Qld., three, 13.12.1925 (A. Musgrave); Como, N.S.W., two, 14.11.1922 (T. G. Campbell). Australian Museum.

The male which was used as a basis for the figure of the femur (Text-fig. 6*a*) is from Moruya, N.S.W., 21.1.1905 (G. W. Compere), and is in the United States National Museum. The hind metatarsus has the anterodorsal bristles longer than is the case in *claripennis*, but not so long as in *georgei*. This may be a distinct species, as there are some long bristly hairs on each side of the prosternal plate on the membrane and there are no such hairs on any other specimen before me now.

var. CLARIPENNIS, new.

This may also be a new species, but further material is essential for a definite conclusion. It agrees with *testacea* in the hairing of the arista, but the wing has

no dark basal mark, the hind femur is armed as in *georgei*, and the hind metatarsus is much shorter bristled on anterodorsal surface (Text-fig. 6*b*).

Length, 11·5 mm.

Type, King George's Sound, W.A., no other data. Australian Museum.

I have seen a specimen from Eastern Australia in which the wings are unmarked, but think it is an aberrant specimen of *testacea*.

Genus RUTILIA Robineau-Desvoidy.

Below I append some notes on recently received examples of this genus. All of the material was received from the Australian Museum and is in excellent condition, providing a basis for a better determination of the specific characters than any in previous accessions.

I have carefully examined Walker's descriptions of species of this genus and in only one or two cases can I suggest their identity. I consider it almost certain that *chersipho*, described without locality record and not included in my catalogue, is *erichsoni*, *idessa* is probably *splendida*, and *uzita* appears to be *formosa*.

In addition to Walker's species there are three described by Thomson, a large number by Macquart, and some by Bigot, which have not yet been definitely identified.

Of Thompson's species I can confidently assign *albopicta* as a synonym of *leucosticta* Schiner. It was described from a specimen taken at Sydney, N.S.W., and the very full description of the markings, including the two white-dusted spots on the posterior portion of the mesonotum, with mention of the apical bristles on the central portion of the second abdominal tergite, leaves no doubt as to the identity of the specimen. There is some doubt as to the priority of the Schiner paper over that of Thomson, but the generally accepted practice is to give precedence to Schiner. The other two Thomson species are not so readily identified, but I feel certain that *pubicollis* is merely *formosa* Robineau-Desvoidy, while *spinipectus* is evidently near *viridinigra* Macquart.

Of the Macquart species two, *media* and *minor*, appear to me to be either synonyms of *Senostoma ruficornis* or species very close thereto. His *assimilis* does not belong to *Rutilia* and, having before me a specimen which I consider belongs to this species, I accept *Paramphibolia* Brauer and Bergenstamm as a valid genus, this species being the genotype. For a consideration of this genus see subsequent text matter. It is not possible definitely to identify all of Macquart's species from the descriptions, but possibly there are some types in the Bigot collection now in the possession of Mr. J. E. Collin which will help to place definitely those so represented. It is possible that *elegans* Macquart is merely *imperialis* Guérin. The specimens used in this paper will all be returned to the Australian Museum and comparison with them ought to make possible the identification of further accessions and, though in one or two cases the exact specific name may be slightly doubtful, they will afford a basis for subsequent work until accurate identifications based upon type examination are available.

The type specimens of Bigot's species are, I assume, all in the collection in Mr. Collin's possession and identification thereof should be readily made by comparison with recent material.

One remarkable feature of the genus is the much elongated penis of the males, shown in Text-figure 7. This character holds throughout the genus, and in *Formosia*, *Amphibolia*, and *Prodiaphania*. Lack of material for dissection prevents

me from dealing at greater length with this feature of the group, but possibly it will be found to be of value in tribal segregation, as it clearly distinguishes the genera above mentioned from *Microtropeza* Macquart, *Amenia* Robineau-Desvoidy, and *Stilbomyia* Macquart, in which the internal portions of the male hypopygium are shorter, more complicated, and partake more of the sarcophagid or calliphorid type. This distinction has already been mentioned by Engel in his paper on Rutiliinae, but he did not arrange the genera in sequence according to this criterion, nor did it influence him to examine the other structures of the abdomen more carefully in *Prodiaphania* and *Chrysopasta.* Had he done so his arrangement of the genera both in his key and text would have no doubt been materially different.

I have not been able to dissect all the species of *Rutilia* available to me, but a careful examination of these and of Engel's figures of the hypopygia of a number of species makes it appear possible to group those now retained in *Rutilia* upon the basis of the hypopygia, in similar manner to that adopted herein on the basis of the frontal armature of the females. The outer forceps of the *formosa* group (Group I) is much narrower and more tapered apically (Text-fig. 7) than in the *vivipara* group (Group II) (Text-fig. 8). There is no outstanding difference in the penis of the two groups judging by the two species I have dissected. The fifth abdominal sternite in all species known to me is very deeply cleft in the males and I have observed no outstanding structural peculiarities in any of the species examined.

I have made no effort to discover the internal structure of the female genitalia, but possibly these will develop specific or generic characters.

I have attempted to key the species of this genus available to me in my previous papers, using in my first attempt the presence or absence of hairs on the parafacials below the bases of the antennae as my first character, and in my second attempt, having found it difficult to apply that criterion to all the material then available, I resorted to the nature of the armature of the hind tibia (Text-fig. 9). Now, with a larger number of species, though both the above-mentioned characters are quite reliable, I find that in applying either or both the result is an incongruous grouping of the species involved. I therefore defer further attempts to key all the species, present below notes on those now on hand, with suggestions as to grouping, and key the *desvoidyi* group.

It appears probable that an intensive study of the genus will result in the segregation of certain groups, one (Group I) in which there are no forwardly directed supraorbitals on the female, and the other (Group II) in which these bristles are present, impressing me favourably as possible subgenera. This division is supported by another character in the females, the group without the anteriorly directed supraorbitals in the female always having an anterior sternopleural bristle in that sex, while the other group lacks that bristle, except in Section 1 in which it occurs in both sexes. Unfortunately the males are not characterized in the same manner, both groups lacking the anterior sternopleural in that sex, except in Section 1 of Group II, so that a rearrangement of the species on the basis of these characters is not attempted at this time.

The subgenus *Senostoma* Macquart has the same characters as *vivipara*, both sexes having the anterior sternopleural present. The arista is distinctly short-haired instead of only pubescent, and the species are more slender and brighter coloured, metallic green, than is the case in *Rutilia, sens. str.*

We have, therefore, groups as below.

Group I.	Group II.	Group II.
formosa Rob. Des.	Sect. 1, *vivipara* Fab.	Subgenus *Senostoma* Mcq.
erichsoni Engel	*micans*, n. sp.	*ruficornis* Mcq.
leucosticta Schiner	*micropalpis*, n. sp.	*albovirida*, n. sp.
imperialis Guérin	Sect. 2, *regalis* Guérin	*hirticeps*, n. sp.
splendida Donovan	*inornata* Guérin	*flavipes* B. & B.
argentifera Bigot	*desvoidyi* Guérin	*nigriceps*, n. sp.
	viridinigra Macq.	
	pellucens Macquart	
	lepida Guérin	
	ethoda Walker	
	potina Walker	
	dubitata, n. sp.	

Group I. *Females without forwardly directed frontals.*

RUTILIA FORMOSA Robineau-Desvoidy.

In my previous papers on this genus I accepted as the above species specimens in which the general colour is a bright metallic emerald or blue-green, without conspicuous white-dusted marks on either the thoracic or abdominal dorsum, and the pleural hairs are preponderantly yellow. In my first paper (These PROCEEDINGS, 53, pt. 3, 1927, 348) I dealt with some variations from type, and suggested the possibility that some of the more distinct of these might prove to be distinct species. I have now before me a number of recently received examples from different localities, some of which present characters not noted by me previously. All agree in lacking the forwardly-directed outer bristles on the upper third of the frontal orbits in the female.

The typical form I accept as possessing a fringe of short closely placed bristles on the entire length of the anterodorsal surface of the hind tibia (Text-fig. 9*a*), with one outstanding longer bristle in the series beyond the middle, a quite conspicuous sub-basal dark mark on each wing, the sternopleural bristles 1 + 1, and no bristles on the presutural lateral area of thorax in the sublateral series, only the posthumerals being represented by one or two of the series.

Localities.—Como, N.S.W., 6.12.1913, and One Tree Hill, Q., 12.12.1925 (A. Musgrave). Australian Museum.

RUTILIA FORMOSA, var.

This variety agrees with the typical form in most particulars, but the hind tibia has the anterodorsal series of bristles as in Text-fig. 9*c*, there being no outstanding submedian bristles in the series.

Localities.—Female, and allotype, One Tree Hill, Q., 12.12.1925 (A. Musgrave), female, lagoon near Lee Farm, Plunkett, Q., 20.12.1925 (A. Musgrave and G. P. Whitley). Australian Museum. Three badly discoloured specimens from Lord Howe Island appear to belong here.

RUTILIA FORMOSA, var. SUBVITTATA, new.

This variety differs from the others in having the dorsum of the thorax more noticeably quadrivittate with black, the wings yellowish at bases and without a sub-basal dark mark, the sternopleurals 2 + 1, and the posterior sublateral bristle present but weak. The antennae are rufous yellow. In other respects like typical *formosa*, the hind tibiae similarly armed, but with three instead of one posterodorsal bristle, and the upper extremities of the frontal orbits are not at

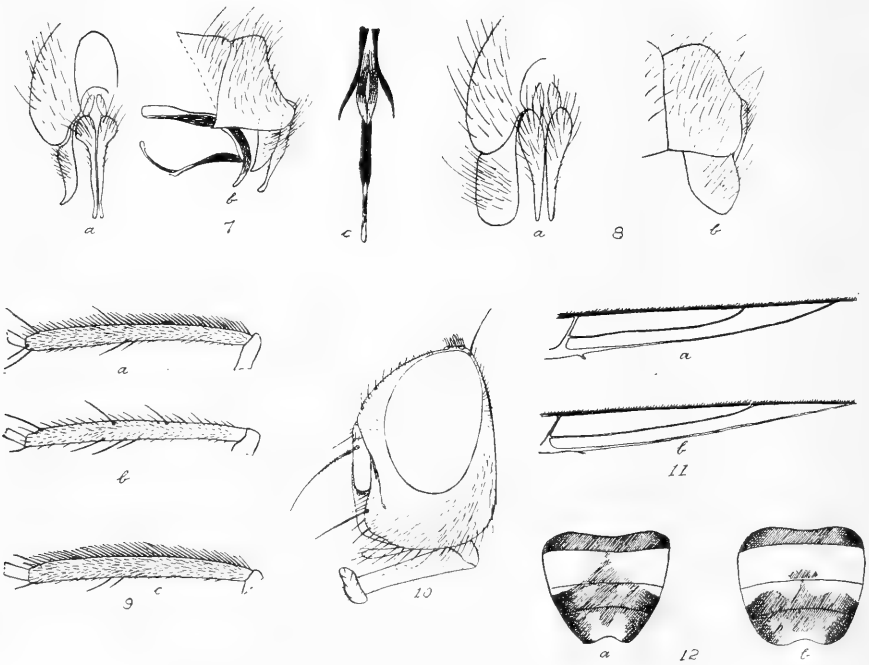
all metallic green in colour. It is possible that the number of sternopleurals varies in the species, but I have seen no other example in which they are more than two in number. Possibly a distinct species.

Locality.—Type, female, King George's Sound, W.A., no other data. Australian Museum.

RUTILIA LEUCOSTICTA Schiner.

Two males and a female before me agree in all essential characters with the type specimen sent to me by the Vienna Museum, and with others so identified by Engel.

Localities.—National Park, N.S.W., two (A. Musgrave), Blue Mts., N.S.W. (A. Musgrave).



Text-fig. 7.—*Rutilia splendida*, hypopygium of male. *a*, rear view; *b*, side view, *c*, penis from above.
Text-fig. 8.—*Rutilia pellucens*, hypopygium of male. *a*, rear view, one side; *b*, side view.
Text-fig. 9*a*.—*Rutilia erichsoni*, hind tibia of male.
Text-fig. 9*b*.—*Rutilia micans*, hind tibia of male.
Text-fig. 9*c*.—*Rutilia regalis*, hind tibia of male.
Text-fig. 10.—*Rutilia inornata*, head of male from the side.
Text-fig. 11*a*.—*Rutilia ruficornis*, auxiliary and first veins of wing.
Text-fig. 11*b*.—*Rutilia pellucens*, auxiliary and first veins of wing.
Text-fig. 12*a*, *b*.—*Formosia atribasis*, dorsal pattern of abdomen of male.

The last mentioned specimen is a male which is rather small for this species, 12 mm. in length, and lacks the fine hairs on the lower half of parafacials, close to the eyes. It agrees in other respects with a much larger specimen of the same sex, though the characteristic golden brown hairs on the bases of the femora are less numerous than is usual in this sex. This species agrees with *formosa* in lacking forwardly-directed supraorbital bristles in the females.

RUTILIA ERICHSONI Engel.

In addition to the characters made use of in my key for distinguishing this species from *splendida*, it appears worth noting that the dorsum of the thorax, when seen from directly above, has only two metallic blue vittae on a deep black ground in *erichsoni*, while in *splendida* the ground colour appears to be green, with four black vittae, owing to the greater development of the pale lateral areas and the presence of a pale central vitta. Also in *erichsoni* there are some golden-brown hairs on the anterior face of thorax on each side, which lie close against the centre of the propleura, and are difficult to detect unless the head stands free of the thorax; in *splendida* these hairs are black. Female without forwardly-directed supraorbitals in both species, the frons bright yellow to upper margin in *erichsoni*, the orbits greyish in *splendida*, becoming darker above, sometimes partly greenish at upper extremities. The lower calypter is white in *erichsoni*, brown in *splendida*.

Localities.—Male and female, King George's Sound, W.A.; female, Queensland, no other data. Australian Museum.

These specimens agree with the three in the type series belonging to the Vienna Museum now before me. It appears worth noting that the type bears two labels, one apparently in Erichson's writing with the name *Agria iniana* Er., the other *erichsoni* det. B. & B. The locality of this specimen is Swan River.

In both females of *erichsoni* the hind tibia has the armature as in typical *formosa*, while in the male it is as in the listed but unnamed variety of that species. In both sexes of *leucosticta* the hind tibia is armed as in *desvoidyi*, there being more than one outstanding anterodorsal bristle present.

RUTILIA SPLENDIDA Donovan.

This species belongs to the same group as those already dealt with above, having no forwardly-directed supraorbital bristles in the female. The hind tibia is armed on the anterodorsal side with either a quite regular series of bristles, or there is one slightly longer bristle in the series beyond the middle.

Localities.—Deep Creek, 20 miles from Kingscote, Kangaroo Is., S. Aust., six (E. Troughton); Como, N.S.W., one, 14.11.1922 (A. Musgrave); Megan, E. Dorrigo, N.S.W., one, 1.1.1923 (A. Musgrave), Ulong, E. Dorrigo, N.S.W., one, Feb.-Apr., 1923 (W. Heron). Australian Museum.

RUTILIA IMPERIALIS Guérin.

This species belongs to the same group as *splendida*, lacking the forwardly-directed supraorbitals in the female, and having the hind tibia with a regular series of anterodorsal bristles. It is closely related to that species, but may be readily distinguished from it by the characters listed in my key to the species of this genus already printed in this series of papers, the most striking of these being the dark coloured hairs on parafacials and cheeks. The abdomen, especially in the female, is frequently marked with a pair of small submedian green spots on tergites 2 and 3.

Locality.—One pair, Fern Tree Gully, Melbourne, V., February, 1928 (A. Musgrave). Australian Museum.

RUTILIA ARGENTIFERA Bigot.

This species is known to me only in the male sex, but I consider it belongs to the *formosa* group, there being but one sternopleural, and the hind tibia having one outstanding bristle in the series on the anterodorsal surface. The parafacials

and cheeks are yellow, with dense golden-yellow dust, and the former are yellow-haired to the lower level of eyes. The calyptrae are fuscous, with the connecting angles pure white.

Locality.—Cairns, N. Qld. U.S. National Museum.

Group II. *Females with one or two forwardly directed frontal bristles.*
Section 1. Sternopleurals 1 or 2 + 1 in both sexes.

RUTILIA VIVIPARA Fabricius.

A shining brownish-red species, with dorsum of thorax broadly infuscated, sometimes almost to scutellum, the dark part grey dusted, more or less aeneous or coppery and with four dark vittae, pleural hairs mostly yellow, those on mesopleura fuscous, abdomen with a dark dorsocentral vitta, whitish dusting on bases of tergites, and the apices of latter appearing dark owing to the presence of strong apical bristles, wings greyish hyaline, without a distinct sub-basal dark mark, legs tawny, hind tibia with the anterodorsal fringe short and irregular and one or two quite strong anterodorsal bristles, parafacials not haired below bases of antennae.

This species is very similar in appearance to *desvoidyi*, but has, besides the above characters, an arcuate series of four or more strong bristles on centre of apex of second visible tergite which are never present in that species, the sternopleurals usually 1 + 1 in both sexes, and three instead of four postalar bristles.

Localities.—Blue Mts., N.S.W.; Tasmania; King George's Sound, W.A.; Albany, W.A., 21.11.1921 (Troughton, Grant and Wright). Australian Museum.

RUTILIA MICROPALPIS, n. sp.

Female.—Head black, centre of face, lower parafacials, and anterior portions of cheeks testaceous, orbits, face, and occiput with white dust, almost silvery, cheeks greyish-white dusted; palpi testaceous; frons and anterior portions of cheeks black-haired, occiput centrally and posterior portions of cheeks pale haired. Thorax metallic green, mesonotum posteriorly, and the scutellum, conspicuously coppery or purplish coloured, mesonotum with white dust and the usual four blackish vittae, anterior lateral margins more conspicuously white-dusted than disc; mesopleura rather conspicuously white-dusted, and with a white-dusted mark above fore coxa; some pale hairs on stigmatal region, on posterior portions of pteropleura and sternopleura, and on hypopleura, the other hairs, including those on sides of the scutellum, dark. Abdomen coloured as thorax, the tergites becoming deeper coloured from near bases to apices, the apices purplish, bases white-dusted, the dark dorsocentral vitta deep green and narrow, incurved ventral portions of tergites green, white-dusted; some golden yellow hairs at base of venter. Legs black. Wings greyish hyaline, with the sub-basal dark mark present. Calyptrae brownish. Halteres dark.

Each orbit with one forwardly-directed upper bristle; hairs ceasing a little below level of bases of antennae. Thorax with about three pairs of quite well developed presutural acrostichals, only two or three bristles between the prescutellar dorsocentrals; postalars 4-5; anterior sternopleural strong; scutellum not evidently flattened, with about ten marginal bristles and a few weaker submarginals. Abdomen with a pair of central apical bristles on second visible tergite, a complete series on apex of third, and a discal series on fourth, the latter

tergite not noticeably concave at apex; tergites not strongly bristled below. Fore tibia normal; fore tarsus subequal to tibia; mid femur with some anterior median bristles; hind tibia with three anteroventral and three posterodorsal bristles, the anterodorsal series closely placed to beyond middle, terminating in a much stronger bristle; hind coxae with weak ventral bristles. Wings normal.

Length, 13-15 mm.

Type, Como, N.S.W., 7.11.1923 (A. Musgrave and T. G. Campbell); paratype, Gunnamatta Bay, Port Hacking, N.S.W., 13.2.1926 (A. Musgrave). Australian Museum.

A quite exceptional species owing to the small size of the palpi. The paratype specimen has a ventral median bristle on both hind tibiae which is absent in the type. The weakly bristled hind coxae in this and the next species readily separate the two species from *vivipara*, in which there are present the usual strong decumbent backwardly-directed bristles characteristic of the *regalis* section of the genus.

RUTILIA MICANS, n. sp.

Female.—This species looks superficially like a larger form of the preceding species, but the head is quite bright yellow, with yellow dust, much like those of most of the *formosa* group, with the interfrontalia brown, and the upper occiput green on each side, and with whitish dust; the frontal hairs are dark, those on cheeks and occiput yellow; apex of third antennal segment brown; palpi yellow. Thorax testaceous, mesonotum broadly metallic emerald-green, with coppery or purplish reflections, especially on hind portion, the whole whitish-dusted and with four dark vittae, the spaces between the median and lateral vittae quite conspicuously white-dusted in front of suture, lateral margins each with four quite noticeable whitish-dusted spots as in *splendida*, the pleura with two large and one smaller white-dusted spots; the pleural hairs almost all yellow, as are those on sides of scutellum. Abdomen metallic green, the dorsum almost entirely purple, with whitish dust, a dark dorsocentral line, and dark apices to tergites; many of the hairs on sides and venter basally golden-yellow. Legs fuscous, tibiae tawny yellow. Wings greyish hyaline, bases brownish-yellow. Calyptrae and halteres yellow.

This species differs from the preceding one in having the palpi much longer, the ocellars sometimes slightly evident, and the forwardly directed supraorbitals much weaker, sometimes lacking. The presutural acrostichals are weak or absent, and the postalars are three in number. Abdomen as in *micropalpis*, the bristles at apex of second visible tergite variable in number. Hind tibia with one or two anterodorsal bristles, and the fringe poorly developed (Text-fig. 9*b*), the ventral bristle absent.

Length, 16-18 mm.

Type and three paratypes, Kosciusko, N.S.W., 5,000 feet, March, 1889 (Helms). Australian Museum.

This species is rather variable in the absence or presence of the forwardly directed supraorbital bristles of the frons, but I consider it better placed in this group than in Group I.

Section 2. Sternopleurals 0 + 1 in both sexes.

Subsection a. Second visible tergite without apical central bristles.—The members of this section are very difficult to differentiate satisfactorily. Structural characters that can be depended upon to distinguish the species invariably are

almost impossible to find and, though many of them are readily distinguishable by colour characters alone, it is hard to put the distinctions into words. Consequently it is with much satisfaction I am able to state that all the species will be subsequently found in the collection of the Australian Museum, where they may be compared with fresh material by interested students. I fear that the hypopygia will afford few outstanding characters for specific determination in the group, but, with plenty of material in hand, some resident dipterist may be able to present a more satisfactory set of differentiating characters than I do at this time. As a contribution to the elucidation of the species of Group II, I present the following key.

Key to the Species.

1. Sternopleura with at least two bristles (1 + 1); second visible abdominal tergite with some strong bristles at apex centrally; hind tibia with two or more posterodorsal and always at least one outstanding anterodorsal bristle 2
   Sternopleura with only one bristle, the anterior one lacking in both sexes 4
2. Palpi not nearly as long as basal segment of fore tarsus, when directed along the proboscis not attaining apex of basal segment of same; hind tibia with a series of closely placed anterodorsal bristles to beyond middle and at apex of the series one much stronger bristle ..... *micropalpis,* n. sp.
   Palpi much longer than basal segment of fore tarsus and extending well beyond apex of basal segment of proboscis; hind tibia with an irregular anterodorsal series of short bristles and one or two longer bristles in the series; postalars three .. 3
3. Thoracic dorsum reddish-brown, disc broadly fuscous, with greyish dust and four dark vittae, the lateral margins and pleura without conspicuous spot-like markings of white dust; scutellum slightly coppery; legs brownish testaceous; hind coxae with long strong backwardly-directed macrochaetae .... *vivipara* Fabricius
   Thoracic dorsum conspicuously metallic emerald-green, overlaid with white dust, the disc with four black vittae anteriorly and between these presuturally with vittae of white dust, lateral margins with four spot-like markings of white dust and the pleura with two similarly coloured spots as in *splendida*; scutellum and posterior portion of mesonotum brilliant coppery or purplish; legs largely fuscous; hind coxae with only weak backwardly-curved bristles .. *micans,* n. sp.
4. Third antennal segment at least as long as distance from its apex to mouth margin; parafacials bare from a little below level of apex of second antennal segment to lower margin ..... *inornata* Macquart
   Third antennal segment very distinctly shorter than distance from its apex to the mouth margin 5
5. Thorax and abdomen quite brilliant metallic emerald-green to blue-green; mesopleura and sternopleura with black hairs 6
   Thorax black or brown, with a more or less evident blue or green tinge on dorsum; abdomen testaceous brown or fuscous, sometimes with coppery, green or purple reflections, or, if the thorax and abdomen are quite evidently metallic green, the hairs on mesopleura and sternopleura are not all black 7
6. Calyptrae fuscous, almost black; abdomen deep metallic green or blue-green, rarely coppery on bases of the tergites, the apices of these and a narrow central vitta black, the bases white-dusted; large species, averaging 20 mm. in length; parafacials haired to about apex of second antennal segment ..... *regalis* Guérin
   Calyptrae greyish or yellowish-white; abdomen subdiaphanous, bright emerald-green on entire dorsum and venter in male, the tergites whitish dusted basally, appearing like mother-of-pearl, the dark dorsocentral vitta and the apices diffuse but distinct, appearing narrow; the female duller in colour and with broader dark marks on dorsum of abdomen; parafacials haired almost to lowest level of eyes ..... *lepida* Guérin
7. Pleura entirely black-haired 8
   Pleura largely yellow-haired 10
8. Parafacials haired to lowest level of eyes, quite densely so in the male, more sparsely so in the female; abdomen in both sexes brownish testaceous, subdiaphanous in the male, and with a rather broad uniform black dorsocentral vitta in that

sex; no bristles on central portion of apex of second abdominal tergite .... *pellucens* Macquart

Parafacials not haired to lowest level of eyes, sometimes almost so, but the abdomen never brownish testaceous and subdiaphanous 9

9. Second abdominal tergite with a number of quite strong bristles on central portion of apex; parafacials haired almost to lowest level of eyes in female; abdomen brilliant green, blue and purple reflections on the entire surface, and with the bases of the tergites white-dusted ..... *ethoda* Walker

Second visible abdominal tergite without strong bristles on central portion of apex; parafacials less extensively haired in the female; abdomen black, with slight aeneous or coppery tinge, and white-dusted bases to the tergites .... *potina* Walker?

10. Mesopleura and sternopleura dark haired on disc; second abdominal tergite sometimes with a pair of distinct though short bristles in middle of apical margin 11

Mesopleura and sternopleura generally entirely pale haired on disc, the sternopleura always so 12

11. About ten strong bristles near hind margin of mesonotum between the dorsocentrals, the outer one on each side much closer to the dorsocentral than to the one mesad of it; dark sub-basal mark on wing dark brown and distinct; presutural acrostichals indistinguishable; no strong bristles in centre of apical margin of second visible tergite; abdomen brownish-black, with green lustre, the dark dorsocentral vitta and dark apices not sharply defined .... *viridinigra* Macquart

About four strong bristles near hind margin of mesonotum between the dorsocentrals, the outer one far from the dorsocentrals; dark sub-basal mark on wing pale brown and indistinct; a pair of moderately strong bristles in centre of apical margin of second visible abdominal tergite; abdomen more conspicuously metallic coloured, the tergites golden green with a broader white-dusted fascia at bases; the black-green dorsocentral vitta and similarly coloured apices to tergites much more marked and sharply defined ..... *desvoidyi* Guérin

12. Thorax and abdomen brownish testaceous, similar in tone to *Formosia confusa*, disc of mesonotum broadly fuscous, with grey dust and four blackish vittae; the abdomen with a rather narrow blackish dorsocentral vitta and more or less evident dark apices to the tergites ..... *dubitata*, n. sp.

Thorax and abdomen quite pronouncedly metallic green, quite similar in tone to *regalis*, the thorax with white dust and four black vittae, the abdomen with dark dorsocentral vitta and apices to tergites ..... *lepida* Guérin, female?

Rutilia lepida Guérin.

In my last published key to the species of this genus I placed *lepida* in the group with most of the pleural hairs yellowish. This applies very well to the female, but I find in the material now before me some males which have the pleural hairs practically all black, and these would therefore run down to section 14 in my key, where they would agree in the dark cephalic hairs with *imperialis*, but, as indicated herein, they belong to a distinct group.

Localities.—Jindabyne, West Tamworth, and Uki, N.S.W., and Gayndah, Queensland.

Rutilia pellucens Macquart.

This species superficially resembles *vivipara* quite closely, but the dorsum of thorax is almost entirely blackish, with a quite evident metallic dark blue tinge, the pleural hairs in male are entirely black, as are the legs, and the dark dorsocentral vitta on the abdomen is much more conspicuous and of uniform width. The legs of the female are not entirely black, the femora and tibiae being partly tawny, and the tarsi black. The parafacials are haired to lower level of eyes, much more distinctly so in male than in female. The postalar bristles are four in number, and the hind tibia has a regular, rather dense, anterodorsal fringe of bristles. Hypopygium as Text-figure 8. Calyptrae brown.

Localities.—Males, Katoomba, N.S.W., December, 1925, Como, N.S.W., 14.11.1922 (A. Musgrave, T. G. Campbell); French's Forest, Sydney, N.S.W., 7.11.1922 (T. G. Campbell); female, Pt. Stephens, N.S.W., 12.11.1919 (A. R. McCulloch). Australian Museum.

Rutilia inornata Macquart.

I have already recorded this species, but had only females prior to receiving the consignment from the Australian Museum. The male has the eyes larger than usual in the genus, and the face from mouth margin upward is more nearly vertical than in any other species (Text-fig. 10). The third antennal segment is not as long in the male as in the female, but it is longer than in allied species.

Localities.—Hunter's Hill, Sydney, N.S.W., Dec., 1919 (A. Read); Como, N.S.W., 6.12.1913, and 14.11.1922 (A. Musgrave); Gordonvale, Qld., Nov., 1917 (Edmund Jarvis). Australian Museum.

Rutilia regalis Guérin.

The largest species of the genus known to me, rarely less than 20 mm. in length. Distinguished from other large species in this group with forwardly-directed orbitals in the female by the bright metallic blue-green thorax and green abdomen, the former being whitish-dusted and with four linear black vittae anteriorly, the abdomen with coppery or golden lustre, a narrow blue-black dorso-central vitta, and similarly coloured apices to tergites; cheeks greenish posteriorly. All pleural hairs and the calyptrae fuscous. Scutellum concolorous with mesonotum, flattened, rather sharply triangular, and with about eighteen marginal bristles. Second abdominal tergite without apical central bristles. Sides of prosternum with stiff black hairs.

Localities.—Narrabeen, nr. Sydney, N.S.W., April, 1928 (Purcell); Sydney, N.S.W., various collectors, October, February; Croydon, nr. Sydney, N.S.W., February, 1928 (Miss W. Hall); Willoughby, N.S.W., January, 1920 (Cheel); Rockdale, N.S.W., December, 1927 (A. E. Baker). Australian Museum.

Rutilia viridinigra Macquart.

Since writing my previous paper on this genus, I have had an opportunity of examining an example of this species identified by Brauer and Bergenstamm. The identification is probably correct as these authors had many of the Macquart types and those of the older authors before them when they wrote their papers on the family. In any case I am inclined to accept their identification of this species.

I have seen no other specimen that agrees *in toto* with this one, though *ethoda* is rather closely similar to it.

Rutilia desvoidyi Guérin.

I accept as this species one specimen so identified by Bigot now in the United States National Museum.

The coppery or purplish hue on the scutellum and posterior portion of the mesonotum is more pronounced than in *viridinigra*, the two narrow dark presutural vittae on the mesonotum are quite pronounced here and not so in the preceding species, and the first visible abdominal tergite is dark blue-green, very distinctly deeper in colour than the anterior portion of the second tergite, while in *viridinigra* it is not noticeably darker than it.

It is possible that there may be variations within the species that will dissipate the stated specific criteria, but fresh material from the same localities is a desideratum to enable one to decide this.

Locality.—New Holland.

Bigot had much material that passed through the hands of Macquart, but there is no means of determining if this specimen is one such.

RUTILIA ETHODA Walker.

Female.—Head black, brownish on face and cheeks, with quite dense whitish dusting, the cheeks slightly shining, and showing bluish-black through the dust posteriorly; antennae fuscous; palpi brown; occiput pale-haired centrally, the other cephalic hairs dark. Thorax black, mesonotum with a quite distinct blue-green tinge, most noticeable between and laterad of the black vittae, on centre of mesopleura, and sternopleura; mesonotum with whitish dust and four moderately broad and diffuse black vittae; scutellum brownish, with a purple lustre; pleural hairs black. Abdomen black, bases of the tergites metallic purple or violet coloured, obscured slightly by whitish dust, apices of tergites deep metallic blue, appearing almost black. Legs black. Wings greyish hyaline, with evident, but not conspicuous, black sub-basal mark. Calyptrae and halteres fuscous.

Head similar to that of *regalis*, but the parafacials are fine haired to almost the lowest level of the eyes, and the facial carina lacks the raised central line which is characteristic of that species. Thorax as in *regalis*, some hairs on the prosternum laterally. Second visible abdominal tergite with about eight bristles on the central portion of apical margin, third with a complete apical series, fourth with a very deep central and apical depression, the disc with a transverse series of long bristles beyond which there are dense long bristly hairs and laterally numerous strong bristles. Hind tibia with a regular series of anterodorsal bristles; hind femur normal, the bristles on apical half of anteroventral surface short and regular.

Length, 18 mm.

Locality.—King George's Sound, W.A., no other data. Australian Museum.

Apart from *vivipara* this is the only species of this section of the genus known to me in which the second visible tergite of the abdomen is conspicuously armed with strong bristles at apex centrally. This character, its much duller coloration, the distinction between the colour of the scutellum and mesonotum, the lack of green colour on the cheeks and of a raised central line on the facial carina, should readily distinguish the species from *regalis*, which it closely approaches in size. It may be that I am in error in identifying this as *ethoda*, but it agrees well with the description.

RUTILIA DUBITATA, n. sp.

Female.—Similar in general coloration to *vivipara* Fabricius. Brownish testaceous, slightly shining; head yellowish-white dusted; thorax with the dorsum largely infuscated, whitish-dusted, and with four blackish vittae; abdomen with a rather narrow but conspicuous black dorsocentral vitta, the apices of tergites, except that of third, indistinctly blackened, the bases of all white-dusted. Third antennal segment fuscous except base; frontal and parafacial hairs fuscous, genal hairs yellowish except on anterior portion where they are dark. Practically all the pleural hairs and many of those on mesonotum pale. Hairs on abdomen black,

some at extreme base of venter and on each side of basal half of fourth visible tergite above yellow. Legs concolorous with body, bases of femora slightly darkened, fore pair pale-haired behind. Wings greyish hyaline, sub-basal dark spot present. Calyptrae and halteres yellow.

Ocellar bristles indistinguishable, forwardly-directed supraorbitals small; face with the carina broad, with a central raised line; parafacials sparsely haired to level of apex of third antennal segment; palpi club-shaped. Prosternum bare; presutural acrostichals not developed; postalar bristles four; scutellar bristles about twelve in number. Abdomen without apical central bristles on second visible tergite, with a complete apical series on third; fourth tergite with a slight apical depression, the apical and lateral bristles sparse, median transverse series strong; no strong bristles on venter. Hind tibia with the anterodorsal fringe shorter than usual; hind coxal bristles not very strong. Wing normal.

Male.—Similar to the female, but the parafacials are bare below the level of apex of second antennal segment, the bases of femora are more evidently darkened, and the tarsi are brown; base of costa slightly explanate.

Length, 15-16 mm.

Type, female, Jindabyne, N.S.W., 3,000 feet, March, 1889 (Helms); allotype, Gordonvale, Queensland, April, 1917, ex scrub (Edmund Jarvis). Australian Museum.

The male may not belong to the same species as the female, but they agree so closely that I deem it proper to place them together pending receipt of more material.

Rutilia potina Walker.

Male and female.—A black species quite similar to *ethoda* Walker in general appearance, but smaller, and with much less evidence of metallic coloration, especially on the abdomen, without bristles on centre of apex of the second visible abdominal tergite, and with the parafacials less extensively haired, rarely to below the apex of second antennal segment. The head is entirely black, including the antennae and palpi, and the dusting is whitish-grey. The thorax has a variable degree of metallic suffusion on the dorsum, but is rarely noticeably blue in tone, while the scutellum is frequently more or less coppery or purple. The abdomen is usually entirely shining black, and the bases of second and third tergites are very narrowly white-dusted above, much more broadly dusted below. Legs black. Pleural hairs all black, mesopleura with disc rather conspicuously white-dusted; mesonotum with quite noticeable whitish dust in front of suture, and there with four black vittae. Calyptrae fuscous.

Length, 17-18 mm.

Localities.—Barrington Tops, N.S.W., 24.1.1927 (T. G. Campbell); Berowra, nr. Hawkesbury R., N.S.W., 11.12.1923 (T. G. Campbell); Como, N.S.W., various dates (A. Musgrave); Canley Vale, N.S.W., Dec., 1925 (C. Harris); Sydney, N.S.W., May, 1928 (W. J. Paul); National Park, N.S.W., 28.1.1928 (W. Bailey); Port Hacking, N.S.W., 7.4.1912 (A. Clark); Eden, N.S.W., January, 1928 (K. Richardson); French's Forest, N. Sydney, N.S.W., 7.11.1922 (A. Musgrave); Enfield, nr. Sydney, N.S.W., no other data. Australian Museum.

It must be noted that the identification of the species described by Walker has been arrived at without an examination of the type specimens and in this manner identifications are merely tentative and subject to confirmation.

The last species listed above appears to be the most common if one can judge from its occurrence in this collection. It somewhat resembles a Tabanid in habitus and might possibly be mistaken for one in the field.

Subgenus SENOSTOMA Macquart.

The arista in this subgenus is generally more distinctly haired than in *Rutilia*, both sexes have the sternopleurals 1 + 1 or 2 + 1, the hind coxae are not powerfully spined, the fourth visible tergite of the female is not concave or depressed at apex, as a rule the species are considerably smaller and much less robust than in *Rutilia*, and the inclination of apices of auxiliary and first wing-veins is different from that of the *vivipara* group (Text-figs. 11*a* and 11*b*). The lack of strong hind coxal bristles, and the presence of an anterior sternopleural bristle in the females, would appear to link the *formosa* group with the present one, and it is noteworthy that the new species *micans* described herein has most of the attributes of *Senostoma*. It will require intensive work to distinguish clearly the various segregates of the genus.

Key to the Species.

1. Parafacials quite densely yellow-haired; pleura and dorsum of thorax almost entirely yellow-haired; pleura green; legs entirely yellow ..... *hirticeps*, n. sp.
   Parafacials bare 2
2. Pleura testaceous yellow, pale-haired ..... *flavipes* Brauer and Bergenstamm
   Pleura green or almost black 3
3. Parafacials largely or entirely fuscous; ocellars in male differentiated as two rather long curved hairs; thorax metallic green with very slight pale dust, without white spots ..... *nigriceps*, n. sp.
   Parafacials entirely bright golden yellow 4
4. Thorax metallic green, without distinct white-dusted spots ..... *ruficornis* Macquart
   Thorax metallic green on dorsum, with eight white-dusted dorsal spots, four in front of and four behind suture, the submedian anterior pair faint; pleura black, with a large white-dusted spot on the mesopleura and another on the sternopleura .... *albovirida*, n. sp.

RUTILIA (SENOSTOMA) HIRTICEPS, n. sp.

Male.—Head testaceous yellow, vertex darker, upper half of occiput metallic green, frontal orbits pale grey-dusted, face and cheeks yellow-dusted, posterior raised portions of cheeks with metallic green sheen; antennae and palpi yellow, arista fuscous; parafacial and occipital hairs yellow, postocular ciliae and frontal hairs fuscous. Thorax metallic emerald-green to blue-green, scutellum testaceous, with a pronounced violet or purple lustre; nearly all of the pleural hairs and many of those of the mesonotum and scutellum yellow. Abdomen semipellucid testaceous yellow, with a quite broad dorsocentral vitta bright emerald-green, and the surface of the tergites with a pronounced green sheen, most evident when viewed from behind; hairs largely yellow below and on the sides. Legs fulvous yellow. Wings hyaline, yellow at bases. Calyptrae and halteres yellow.

Frons at vertex about one-tenth of the head width; inner verticals weak; ocellars undeveloped; parafacials haired on entire extent; facial carina broadly rounded; arista very short haired. Thorax with the dorsocentrals and presutural acrostichal bristles distinct but not strong; anterior sternopleural sometimes duplicated; postalars 3. Abdomen ovate, second tergite sometimes without the pair of apical central bristles. Hind tibia with a series of short closely-placed bristles and one much longer bristle on anterodorsal surface, and two or three posterodorsal bristles.

Length, 11-12 mm.

Type, Moonbar, 3,000-3,500 feet, Monaro, N.S.W., March, 1889 (Helms); paratype, Ulong, Dorrigo, N.S.W. (W. Heron). Australian Museum.

The paratype differs from the type in having the mesonotal hairs more largely dark, and the abdomen more pronouncedly metallic blue-green.

RUTILIA (SENOSTOMA) FLAVIPES Brauer and Bergenstamm.

A specimen of this species in rather greasy condition from the Austrian National Museum differs from *ruficornis* in having the pleura, including humeri and lateral margins of mesonotum, testaceous yellow, the venter, including incurved portions of the tergites, of same colour, the pleural hairs mostly yellow, only some on the upper portion of the mesopleura dark. Legs entirely yellow.

Locality.—New Holland, no other data.

RUTILIA (SENOSTOMA) NIGRICEPS, n.sp.

Male.—A smaller and darker species than any of the others before me. Frons black, face dark brown, parafacials fuscous above, cheeks and occiput fuscous, with a green tinge, frontal orbits and parafacials yellowish-grey-dusted, changeable; antennae fuscous, base of third segment reddish; aristae fuscous; palpi testaceous yellow; occipital and posterior genal hairs yellow, the other cephalic hairs black. Thorax dark metallic green, the pleura almost black, mesonotum slightly white-dusted, and with four black vittae, all hairs black. Abdomen brassy or golden green, with a broad diffuse dark green dorsocentral vitta, the tergites slightly pale-dusted; all hairs dark. Legs black. Wings greyish hyaline, darker basally. Calyptrae brown. Halteres brownish-yellow.

Structurally similar to *hirticeps*, but the ocellars are distinguishable, the parafacials are bare, the facial carina is flattened, the aristae are even shorter haired, and the species is smaller.

Length, 7-9 mm.

Type and three paratypes, Ulong, E. Dorrigo, N.S.W., no other data (W. Heron). Australian Museum.

RUTILIA (SENOSTOMA) RUFICORNIS Macquart.

This species is somewhat doubtfully identified by me as represented by a number of specimens of both sexes now before me. There is a close agreement between the males and Macquart's description, but, if my identification of *flavipes* is correct, I cannot understand why Engel accepted the two as synonymous. The colour of the legs is quite variable in the male, being sometimes fuscous with the tibiae slightly paler; at other times the tibiae are fulvous testaceous and much paler than the femora and tarsi; the female has the entire legs fulvous testaceous. In the male the abdomen is fulvous testaceous, with a black or dark green median vitta of variable extent and a very pronounced green sheen over the entire surface, most evident on the fourth visible tergite; the abdomen of the female is entirely metallic emerald-green, with a coppery tinge in some lights, and no dark central vitta.

Length, 11-14 mm.

Localities.—Como, N.S.W., French's Forest, N. Sydney, N.S.W., Oct.-Dec. (A. Musgrave, T. G. Campbell). Australian Museum.

RUTILIA (SENOSTOMA) ALBOVIRIDA, n. sp.

Female.—Head orange, with bright orange-yellow dusting on frontal orbits, face, cheeks, and lower half of occiput, upper half of postocular orbits silvery-dusted, vertex and upper extremities of frontal orbits fuscous, upper half of occiput metallic green, interfrontalia dark brown; apical half or more of third antennal segment and all of aristae fuscous; palpi yellow. Thorax bright metallic emerald-green, mesonotum with two faint blackish lines in front of suture and laterad of each of these a white-dusted vitta which is usually distinct only in front, a pair of large white-dusted spots on each lateral margin, one presutural, the other post-sutural, and a smaller spot on each side of disc near hind margin in line with the presutural vittae; pleura with two conspicuous white-dusted spots, one on the mesopleura the other on the sternopleura. Abdomen metallic green, with coppery and purplish reflections, disc of second and third visible tergites each with two small faint white-dusted submedian spots, those on second almost indistinguishable, second with a conspicuous spot of same colour on each lateral curve and another on extreme lateral edge, third with the one on lateral curve quite inconspicuous, the other large, fourth with all the spots present and more or less united. Wings hyaline, black near bases. Calyptrae and halteres fuscous.

Frons at vertex about one-fourth of the head width, each orbit with one or two forwardly-directed supraorbitals, a series of incurved inner marginals, and some short black lateral hairs; parafacials bare, about half as wide as eye in profile; cheek with yellow hairs; ocellars short but distinct; inner verticals rather long, outer pair undeveloped; third antennal segment not as long as distance from its apex to mouth margin; arista pubescent; vibrissae well differentiated. Thorax with dorsocentrals and acrostichals well developed, posterior sublateral lacking; prosternum entirely bare; all pleural hairs black; sternopleurals 1 + 1; postalars 3. Abdomen ovate, second tergite sometimes with a weak pair of central apical bristles, third with a complete apical series, fourth not concave at apex, with some discals and no strong apicals above. Hind tibia missing in both specimens before me. First posterior cell of wing narrower than usual at apex.

Length, 10-12 mm.

Type and paratype, Yeppoon, Q., October, 1924 (A. Musgrave). Australian Museum.

This species resembles a small specimen of *leucosticta*, but the latter lacks the forwardly-directed supraorbitals in the female, and the abdomen is differently marked.

Genus CHRYSOPASTA Brauer and Bergenstamm.

I have already dealt with this genus and now add some data bearing on the genotype.

CHRYSOPASTA ZABRINA (Walker).

I am confident that this name applies to the genotype, *versicolor* Brauer and Bergenstamm and, having priority over it, should supplant it.

Walker described his species as a *Rutilia* and gave as its locality Western Australia. His description is quite unmistakable, the peculiar white-dusted eye-orbits and the black spot-like vittae of the thorax being characteristic of this species only, as far as I am aware at this time. The female has two strong forwardly-directed supraorbitals on each orbit, the ocellars quite well developed, and two or three anterodorsal bristles on the hind tibia, while the male has neither

of the strong fronto-orbitals, and the strong anterodorsal bristles on the hind tibiae are more numerous and not so clearly differentiated from the other setulae.

I have seen no recent specimens of this species.

Genus Formosia Guérin.

In my preceding papers on this tribe I separated *Formosia* from *Rutilia* on the character of the postalar region, the former having the suprasquamal ridge bare and the postalar declivity more or less extensively haired centrally, while *Rutilia* has many hairs on the suprasquamal ridge and the postalar declivity bare on centre. Previous writers had separated the genera on the nature of the hairing of the artista, subplumose in *Formosia*, and pubescent or very short-haired in *Rutilia*. Accepting the first mentioned character as the criterion for distinguishing the genera, I have in my first paper on the genera, included in *Formosia* two of the species included in it by Engel and two others placed in *Rutilia* by that author. This difference in treatment is due to the above facts. Typically the genus has the arista with its longest hairs about half as long as the width of third antennal segment, but some of the species I place herein have the arista no longer haired than in typical species of *Rutilia*, the hairs being hardly distinguishable. However, I summarize the characters in the key to the species presented below, which will clarify the matter. There is some diversity in the extent of the hairing of the postalar declivity, some species, including the genotype and *flavipennis*, having the hairs present on almost the entire height of the central portion, while others have the hairs confined to the upper margin of the central portion just below the strong bristle.

Key to the Species.

1. Longest hairs on arista fully half as long as width of third antennal segment; frontal orbits and upper half or more of parafacials bright metallic emerald-green, without forwardly-directed fronto-orbitals in the female; wings not blackened at bases 2

   Longest hairs on arista not longer than its basal diameter; frontal orbits and parafacials not metallic green 3

2. Legs black; hairs on mesopleura fuscous ..... *mirabilis* Guérin

   Legs yellow; all the pleural hairs yellow ..... *flavipennis* Macquart

3. Thorax and abdomen with conspicuous spots or markings of white dust 4

   Thorax and abdomen without conspicuous markings of white dust, at most with inconspicuous greyish or whitish dusting on them 5

4. Species brilliant metallic blue or blue-green, mesonotum with two narrow presutural vittae and two large spots on each side white-dusted, one of the lateral spots presutural, the other postsutural; pleura with two white-dusted spots; second abdominal tergite with six, third and fourth each with four rounded spots of white dust; legs entirely black; head orange-yellow, yellow-dusted, with a green mark on each side of upper margin of occiput; pleural hairs all black; hairs on the postalar declivity present on only the upper margin at centre .. *frontosa*, n. sp.

   Species black, without conspicuous metallic coloration, mesonotum presuturally with four vittae and a small anterior central mark, and posteriorly with four spots, of dense white dust; pleura with two similar spots; abdomen densely whitish-grey-dusted, with black marks as follows: first tergite, a transverse mark on centre of second tergite near apex, a cordate central spot, and a much larger one on each lateral curve, on third tergite, all three of these present on fourth and connecting with the spots on third, and a spot on each extreme lateral margin of each tergite; legs fulvous yellow; head testaceous, densely grey-dusted, frons and upper occiput fuscous; pleural hairs yellow; hairs on the postalar declivity present on almost the entire height at centre ..... *speciosa* Erichson

5. Wings not noticeably blackened at bases; brownish testaceous species, dorsum of thorax metallic blue, rather dull, scutellum testaceous, with a purplish tinge;

mesopleura and sternopleura not more conspicuously dusted than other parts of pleura, all the pleural hairs and the calyptrae pale; legs fulvous testaceous; hairs on postalar declivity present only on the upper margin in centre; female with forwardly-directed supraorbital bristles ..... *confusa*, n. sp.

Wings deep black from extreme bases to the apices of basal cells; metallic blue or green species, with deep black markings on thorax and abdomen; mesopleura, and to a lesser extent the sternopleura, with conspicuous white-dusted markings; pleural hairs, calyptrae, and legs black; hairs on the postalar declivity present on almost the entire height at centre 6

6. Dorsum of thorax when seen from directly above uniformly metallic emerald-green, not noticeably white-dusted in front of suture, and with four black vittae, the submedian pair ceasing a little behind suture; large species, 17-19 mm. in length ..... *smaragdina*, n. sp.

Dorsum of thorax black, with a green tinge in female, and in that sex quite distinctly pale grey-dusted in front of suture, in male dull blackish-green, not so distinctly metallic as in *smaragdina*, in both sexes with four black vittae as in that species; smaller species, 14-15 mm. in length ..... *atribasis* Walker

FORMOSIA MIRABILIS Guérin; FORMOSIA FLAVIPENNIS Macquart.

I have nothing to add to what I have already reported upon these two species, except that I have seen two specimens labelled *flavipennis* by Engel that appear to me to belong to *mirabilis*, the legs being entirely black, and some of the hairs on the mesopleura dark. These are from New Pommern.

I consider that a careful examination of a long series of both sexes of these two forms is essential to a definite conclusion as to specific identities.

FORMOSIA MONETA Gerstaecker; FORMOSIA CALLIPYGUS Gerstaecker.

These two species are as yet unknown to me. The frontal orbits and parafacials are green as in the female in the foregoing species, and the third antennal segment is much longer than in some of the other species which follow in this paper, being about three-fourths as long as the basal segment of fore tarsus.

From Engel's descriptions I would infer that these species resemble *atribasis* Walker and *smaragdina* mihi rather closely, except for the green orbits and lower occiput and hind portions of the cheeks. The abdomen has evidently less extensive green markings on the dorsum, the third and fourth tergites having green dorsal spots of lesser extent, especially the third.

FORMOSIA SPECIOSA Erichson.

This species was included in *Amphibolia* in my catalogue of Australian Tachinidae, although my opinion is that it belongs to *Formosia*, and I had previously placed it in this genus.

I have before me a discoloured female submitted by the Australian Museum, the only other example available being from New South Wales. Engel has recorded it from Queensland. The Museum specimen is from Victoria.

The original specimens described by Erichson are not amongst the types sent me by the Vienna Museum.

FORMOSIA CONFUSA, n. sp.

Male and female.—Superficially this species closely resembles *Rutilia vivipara* Fabricius, but it lacks the hairs on the suprasquamal ridge and falls in the segregate of *Formosia* in which the hairs on the postalar declivity are confined to the upper margin, though its dull coloration makes it appear out of place here. Head testaceous yellow, interfrontalia reddish-brown, orbits, face, and cheeks greyish-yellow dusted; third antennal segment browned or blackened except at

base; palpi pale; occipital and genal hairs yellow; postocular ciliae and frontal hairs black. Thorax brownish testaceous, disc of mesonotum entirely infuscated, with a blue-green metallic tinge, slightly white-dusted, and with four interrupted black vittae, dorsal hairs pale on margins, black on disc; pleural hairs yellow, some on central upper portion of mesopleura black; scutellum semipellucid brownish testaceous, shining, with coppery or purple reflections. Abdomen brownish testaceous, distinctly shining, with coppery or purple lustre, bases of tergites slightly grey-dusted, dorsum with a dark dorsocentral vitta which is rather narrow and not very conspicuous, the apices of tergites appearing narrowly dark owing to the presence of black apical bristles; hairs mostly black, some pale hairs at apex and along venter. Legs brownish testaceous. Wings greyish hyaline, inconspicuously pale brown at bases. Calyptrae and halteres yellow.

Frons of male at vertex about one-ninth of the head width, that of female one-fifth of head width, orbits with an inner marginal series of fine incurved bristles and many lateral hairs, the female with one or two fine forwardly-directed outer supraorbitals on upper third of each orbit; parafacials bare below bases of antennae, third segment of latter hardly more than half as long as distance from its apex to mouth margin; arista pubescent; three or four bristles above vibrissa, the latter well differentiated. Thorax with the dorsocentral and acrostichal bristles distinct, no posterior sublateral bristle; sternopleurals 2 + 1; scutellum slightly flattened, subtriangular, with about twelve marginal bristles. Second abdominal tergite with six or more apical central bristles, third with a complete apical series, the central pair on each in front of the others, fourth with a transverse series of discal bristles and beyond these many weaker bristles and hairs; all tergites with strong apical bristles ventrally to lateral edges. Mid tibia in both sexes with a strong submedian ventral bristle; hind tibia with the anterodorsal fringe inconspicuous, short, one or two of the bristles beyond middle outstanding.

Length, 15-18 mm.

Type, male, allotype, and 2 paratypes, Deep Creek, 20 miles from Kingscote, Kangaroo Island, S. Aust. (E. Troughton); paratypes, three, Kosciusko, N.S.W., 3,000 feet, March, 1889 (Helms); Jindabyne, N.S.W., two, 3,000 feet, March, 1889 (Helms); Berowra, nr. Hawkesbury, N.S.W., one, 11.12.1923 (T. G. Campbell) [Australian Museum]; Katoomba, Blue Mts., N.S.W., two, 1912 (Dodd).

The last two specimens were identified as *desvoidyi* by Engel and recorded as that species by him in his paper on the group.

Formosia frontosa, n. sp.

Male.—Brilliant metallic blue, with conspicuous spots of white dust on thorax and abdomen. Head bright orange-yellow, orbits, parafacials, and cheeks densely yellow-dusted, ocellar spot fuscous, upper margin of occiput green laterally, occiput and cheeks with fulvous hairs, postocular ciliae and frontal hairs black; antennae and palpi orange-yellow, third segment of former and the aristae brownish. Thorax green on disc of mesonotum, and with the following conspicuous white-dusted markings: two narrow submedian vittae in front of suture, a large spot extending from middle of each humerus almost to suture, a similar lateral spot behind suture, a very small spot mesad of the posterior extremity of the humeral one, and two pleural spots, one on mesopleura and the other on sternopleura; all thoracic hairs, and the spiracular coverings black. Abdomen green centrally on dorsum, the apices of third and fourth tergites golden green, tergites with the following rather

large, changeable spots of white dust: six on second tergite, four on third, and four on fourth, the last sometimes all connected; all abdominal hairs black. Legs black. Wings hyaline, fuscous at bases. Calyptrae and halteres fuscous.

Frons at vertex as wide as parafacial and about twice as wide as length of third antennal segment; ocellar region rather densely haired, the ocellar bristles not differentiated, inner verticals moderately long, outer pair undeveloped, orbits with an inner marginal series of fine bristles and laterad of these erect black hairs, both ceasing at bases of antennae; parafacials bare, a few black setulose hairs above the vibrissa, the latter outstanding; arista pubescent; facial carina flat. Posterior sublateral bristle absent, dorsocentrals all present, only the posterior pair strong, the presutural acrostichals not very strong; anterior sternopleural bristle very fine and short; scutellum subtriangular, not much flattened on disc, with about ten marginal bristles. Abdomen convex, but little tapered to apex, first and second visible tergites without central apical bristles, third and fourth each with a complete apical series and some shorter bristles encroaching on disc from hind margin centrally; no transverse series of macrochaetae on incurved portions of tergites. Femora attenuated on apical halves or less, tibiae and tarsi slender, mid tibia without a ventral bristle; hind femur with long bristles on basal half of anteroventral and posteroventral surfaces, and short bristles on apical half of anteroventral surface; hind tibia with the anterodorsal fringe indistinguishable, and one short bristle near middle on that surface, one posterodorsal, and three long anteroventral bristles. Fourth wing-vein nearly straight beyond angle.

Length, 16-18 mm.

Type and paratype, Jindabyne, N.S.W., 3,000 feet, March, 1889 (Helms). Australian Museum.

I have before me a specimen from the Austrian National Museum in Vienna which appears to be the female of this species. It differs from the male in having the presutural vittae on mesonotum less distinct, broader, and a third faintly-dusted vitta between them. The abdomen is crushed, but I can, I believe, detect the white-dusted markings that distinguish the male, though the spots on fourth tergite are fused.

Locality.—New Holland.

This specimen bears the label "*frontosa* B. & B." and below another which indicates that it belongs to a new genus, though I am unable to decipher all of the writing. Brauer and Bergenstamm's name *frontosa* is a *nomen nudum*, but I utilize the name herein for the species, the validity of the name dating from this paper.

Formosia atribasis Walker.

The male has the pale portions of the abdomen bright metallic emerald-green, seen from above it is marked as in Text-figure 12*a*; the female has the green portions of abdomen duller and largely or entirely suffused with reddish or coppery colour and marked as Text-figure 12*b*. It should be noted that the central apical armature of the second visible abdominal tergite is always much weaker in the male than in the female, and that in the former it is frequently lacking.

Locality.—Gordonvale, N.Q., Nov., 1919 (E. Jarvis). Australian Museum.

I have seen this species from Cairns and Kuranda, Queensland. There is no doubt as to this being *smaragdifera* Bigot, but its identity as *atribasis* Walker is not so certain.

Formosia smaragdina, n. sp.

Male and female.—This species is larger than *atribasis* (18 : 15), and the material before me shows no sexual dimorphism in colour, the pale portions of the thorax and abdomen being bright emerald-green in both sexes, with the markings almost the same in both, resembling those of the female of the preceding species, though there is a forward extension of the dark apical mark on second tergite in the male. The species is similar to the preceding species except as stated in the foregoing key.

Length, 18-19 mm.

Type, female, Gordonvale, N.Q., Oct., 1917 (E. Jarvis), Australian Museum; allotype, Cairns, N.Q. (A. P. Dodd), and one female paratype, same locality and collector as type (U.S. Nat. Mus.).

It would appear rather remarkable if this species has escaped description until now, as it is such a striking form, but I can find no description that fits it.

Genus Amphibolia Macquart.

I cited the characters of this genus in my first paper on the tribe, and have nothing to add to that citation and the information contained in my key to the genera in a subsequent paper of this series.

Amphibolia valentina Macquart.

The black markings of the abdomen are rather variable in both sexes, as is also the number of discal abdominal bristles. The female has a forwardly-directed upper frontal bristle, and in both sexes there is one outstanding bristle in the anterodorsal series of bristles on the hind tibia. Head of male as in Text-figure 13.

Localities.—One male, Lord Howe Island, 4.1.1922 (A. Musgrave); one female, same locality, no other data; one female, Tasmania, no other data; two females, King George's Sound, W.A., no other data. Australian Museum.

One female from Sydney, N.S.W. (Thorey, 1864) sent by the Austrian National Museum bears the label "*thoreyi*, det. B. & B.". This specimen was examined by Engel also.

Genus Paramphibolia Brauer and Bergenstamm.

This genus possesses similar characters to *Rutilia*, falling in my key to the genera of this tribe in the section with setulose hairs on the suprasquamal ridge. It differs from *Rutilia* in having strong discal bristles on the second and third tergites of the abdomen, and from *Amphibolia* in having hairs on parafacials to lower level of the eyes. The separation from *Amphibolia* would appear to be rather weak if one considers that in *Rutilia* the character upon which the distinction is based is not utilized for the division of that genus, and that species with both bare and haired parafacials occur therein, but the genotype of *Paramphibolia* is radically different in general habitus from that of *Amphibolia*, the shape of the head is quite distinct (Text-fig. 14), and the hind tibia has a different armature.

For a more complete characterization of the genus see description of the species.

Genotype, *Rutilia assimilis* Macquart.

PARAMPHIBOLIA ASSIMILIS (Macquart).

Male.—Head reddish testaceous, frons, occiput, most of parafacials, third antennal segment except base, and the aristae, fuscous, frontal orbits, parafacials, upper part of face, occiput, and cheeks pale-grey-dusted; palpi yellow; hairs on parafacials, cheeks, and occiput yellow, postocular ciliae and frontal hairs fuscous. Thorax reddish testaceous, disc of mesonotum broadly fuscous, whitish-dusted, and with four dark vittae; pleura except mesopleura fuscous; scutellum reddish testaceous, shining; pleural hairs mainly yellow, some black hairs on centre of mesopleura; mesonotum brownish-haired on disc, pale-haired on sides. Abdomen reddish testaceous, shining, with a uniformly wide black dorsocentral vitta, and faint white dusting on bases of tergites when seen from behind, black-haired above, with some yellow hairs below. Legs black, central portion of tibiae reddish to a variable extent, sometimes entirely so, femora with yellow hairs and black bristles. Wings greyish hyaline, with very faint sub-basal brown mark. Calyptrae yellowish. Halteres yellow.

Head in profile as Text-figure 14; frons at vertex about one-sixth of the head width, orbital hairs and postocular ciliae long, inner verticals long, outer pair undeveloped, ocellars undifferentiated; parafacials haired to lowest level of eyes; arista bare. Thorax with 3 or 4 + 4 pairs of dorsocentrals, 3 + 2 acrostichals, two pairs of posterior intra-alars, three postalars, sternopleurals 1 + 1, some pale hairs on sides of the prosternum, and about twelve scutellars. Abdomen ovate, second visible tergite with two or three pairs of discals, and an arcuate series of about twelve apicals, third with a pair of discals and a complete arcuate series of apicals beyond which in centre there are some weaker bristles, fourth tergite with a pair of discals anteriorly and from middle to apex rather densely bristled, tergites 2 to 4 with apical bristles below; hypopygium with the apical forceps very slender, contiguous to apices. Mid tibia with a submedian ventral bristle; hind femur with long bristles on basal half of anteroventral and postero-ventral surfaces, and some moderately long bristles near apices on anteroventral surface; two or three outstanding and a number of shorter bristles on anterodorsal surface of hind tibia.

Length, 13 mm.

Locality.—Mt. Wellington, Tasmania, 3,500 feet, 15.1.1928 (A. Musgrave). Australian Museum.

Genus CHAETOGASTRINA, nov.

This genus is very similar to *Paramphibolia*, agreeing with it in structure of the head and thorax, but there are no parafacial hairs below level of bases of antennae. From *Amphibolia* it differs in having the ocellar bristles well developed in the male, and in the armature of the hind tibia, as well as in the general shape of the head.

Genotype, the following species.

CHAETOGASTRINA STOLIDA, n. sp.

Male.—Black, hardly shining, with grey dust on head, thorax, and abdomen. Head densely whitish-grey-dusted except on interfrontalia; lunule and apex of second antennal segment testaceous; palpi testaceous, dark at bases; occipital hairs except postocular ciliae yellow, the other cephalic hairs black. Mesonotum when seen from behind whitish-grey-dusted and with five black vittae, the outer one on each side broadest and interrupted at suture, the others ceasing about

midway from suture to hind margin; prothoracic spiracle pale brown, metathoracic one fuscous; all hairs on thorax black. Second visible abdominal tergite pale-grey-dusted on anterior half when seen from behind, posterior half of tergites 3 and 4 brown dusted, slightly checkered; all abdominal hairs black. Legs black. Wings greyish hyaline, slightly darker at bases. Calyptrae fuscous, margins darker. Halteres brownish-yellow.

Eyes bare; frons at vertex fully one-sixth of the head width, inner verticals moderately long, outer pair undeveloped, ocellars of moderate length, curved forward and slightly divergent, orbits with a series of fine incurved inner marginal bristles and numerous long lateral hairs, the bristles running slightly outward below and extending but little below antennal insertions, the hairs ceasing at same level; facial carina evenly rounded, broader than third antennal segment above, narrowed below; head in profile as Text-figure 15. Thorax with 3 or 4 + 4 dorsocentrals, 2 + 2 acrostichals, 2 intra-alars, sternopleurals 1 or 2 + 1; scutellum with about twelve marginal bristles and about six weaker submarginals, the hairs covering entire sides of basal third. Abdomen with first visible tergite unarmed at apex, second and third each with a pair or more of discal bristles and the apical series curving forward centrally, becoming distinctly preapical in middle; bristles on fourth tergite numerous, strongest on disc; sternites quite numerously bristled, fifth without strong bristles. Hind femur with several long strong bristles on basal half of anteroventral and posteroventral surfaces and some shorter bristles on apical half of anteroventral; hind tibia with three or four long anterodorsal and posterodorsal bristles, and one anteroventral bristle; ventral bristle on mid tibia short. Base of third wing-vein finely bristled above and below.

Length, 15 mm.

Type, and three paratypes, Barrington Tops, N.S.W., 20.1.1927 (T. G. Campbell). Australian Museum.

The three foregoing genera fall in the same section of my generic key, distinguished from *Rutilia* by the presence of discal abdominal bristles, and may be separated as below.

Key to the Genera.

1. Parafacials haired to lowest level of eyes; hind tibia with about three outstanding bristles on anterodorsal and posterodorsal surfaces ..... *Paramphibolia* B. & B.
   Parafacials entirely bare from below level of bases of antennae 2
2. Ocellars entirely lacking in male, slightly developed in female; anterodorsal surface of hind tibia with an almost regular series of short bristles, and one outstanding bristle beyond middle, the posterodorsal surface normally with but one bristle beyond middle ..... *Amphibolia* Macquart
   Ocellars quite well developed in male; anterodorsal and posterodorsal surfaces of hind tibia with about three outstanding bristles on each ..... *Chaetogastrina*, n. gen.

I know of no record of *Paramphibolia assimilis* Macquart since its original description. It will thus be of considerable importance to Australian entomologists to have all the above three genera in the Australian Museum for purposes of comparison, as Macquart's types which are still in existence are all in Europe.

Genus Chaetogaster Macquart.

This genus appears to have its closest affinities with this tribe, possessing the same type of head, characterized by the broad regularly-rounded central vertical carina of the face, and the pubescent arista. The parafacials are bare below

bases of antennae, the cheek is almost as high as eye in the male; facial ridges bare; palpi long and slender. Prosternum bare, centre of propleura haired, some short hairs just below lower calypter, suprasquamal ridge bare; postalar declivity with a few hairs on upper central portion; metasternum more elevated than in *Rutilia* and quite evenly rounded, bare. Second, third, and fourth abdominal tergites with discal and apical bristles; sternites not strongly bristled at apices. Fore tibia with one or two weak bristles near base on anterodorsal surface. Wing as in *Rutilia*. Upper calypter short, rounded at apex.

In my key to the genera of Rutiliini already printed, this genus will run down to caption 5, section two. It fits best in the subgenus *Euamphibolia* Townsend, but differs from it in possessing two pairs of discal bristles on second and third abdominal tergites.

Chaetogaster violacea Macquart.

I have seen a series of specimens in the United States National Museum collection which agree well with Macquart's description, but the violet colour is not so pronounced as one might expect it to be from the name, in fact the insect is largely black, with a violet tinge on posterior half of mesonotum and particularly on the scutellum, while the abdomen is apparently rather reddish on sides, though this colour is obscured by the purplish tinge. The dorsum of thorax is whitish-dusted and has on the anterior portion five dark vittae, the abdomen when seen from behind is whitish-dusted on each side of the tergites of basal half. Legs black. Wings smoky, very noticeably yellow at bases and along costa to beyond middle. Calyptrae yellow. Halteres brown.

Length, 15-17 mm.

Locality.—Bega, N.S.W., 30.1.1903 (W. W. Froggatt).

Tribe **Dexiini.**

This group has generally been ranked as a family or subfamily, the distinguishing characters being the distinctly haired arista and the lack of the posterior sublateral bristle on thorax. I consider tribal rank all it is entitled to.

Genus Mesembriomintho Townsend.

This genus has the face without a central vertical carina. The other characters are listed in the subjoined key to genera herein.

There are two specimens of the genotype, *compressa* Townsend, in the United States National Museum; these are all that I have seen.

Genus Prosena St. Fargeau and Serville.

This genus is the only one as yet known to me from Australia in which the proboscis is exceptionally elongated and slender. The palpi are quite short and rather wide.

Curran has published a key to the Australian species known to him (*Ent. Mitt.*, 16, No. 5, 1927; see also Aldrich, *Id.*, 17, No. 2, 1928, 130).

Genus Zosteromeigenia Townsend.

A monobasic genus of which I have seen only the type specimen of the genotype (*mima* Townsend), in the United States National Museum.

Despite the haired arista I have doubts as to the propriety of placing the genus in this tribe.

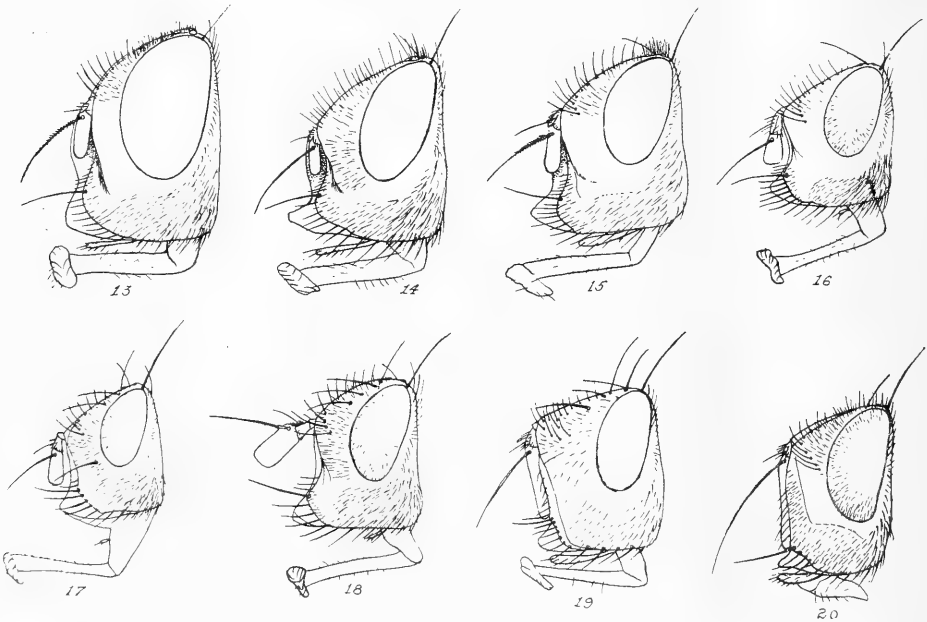
Genus Dexia Meigen.

I have seen no species of this genus from Australia and none such may occur, despite the fact that there are several species placed in it by the older authors. In general all species agreeing in a general manner with the genotype were considered to belong here, but more recent workers have utilized characters for generic segregation which remove many of the old species to other genera.

The characters cited in the generic key were obtained from an examination of the genotype, *rustica* Fabricius, a European species.

Genus Rhinomyiobia Brauer and Bergenstamm.

The characters cited in the generic key were derived from an examination of *plumifera* Bezzi, a species occurring in Samoa and the Fiji Islands.



Text-fig. 13.—*Amphibolia valentina*, head of male from the side.
Text-fig. 14.—*Paramphibolia assimilis*, head of male from the side.
Text-fig. 15.—*Chaetogastrina stolida*, head of male from the side.
Text-fig. 16.—*Linnaemyia bicolor*, head of male from the side.
Text-fig. 17.—*Apalpus dorsalis*, head of male from the side.
Text-fig. 18.—*Chaetophthalmus brevigaster*, head of male from the side.
Text-fig. 19.—*Quadra ornata*, head of male from the side.
Text-fig. 20.—*Zebromyia obesa*, head of male from the side.

Tribe **Linnaemyiini.**

This tribe has frequently been referred to as Micropalpiini, but the genus *Micropalpis* was erected by Macquart by combining three of Robineau-Desvoidy's genera and, *Bonnettia* being the first included, *Micropalpis* has been placed as a synonym of it. *Linnaemyia* was the second and *Bonellia* the third of the included genera.

In a recent paper on the Diptera of the Belgian Congo (*Bull. Amer. Mus. Nat. Hist.*, 57, 1928, 398) Mr. C. H. Curran has listed the three above-mentioned genera and four others as synonyms of *Linnaemyia*, but at present we are not interested in other than Australian forms, all of which before me have been compared with the genotypes of *Bonnettia*, and *Linnaemyia*, i.e., *comta* Fallen, and *vulpina* Fallen, respectively.

In the present paper I deal with three genera which belong to the tribe, the definition of the latter being as below.

Second antennal segment distinctly shorter than third; hind coxae above bases of femora without hairs or bristles; lower calypter subtransverse on hind margin, without a distinct bulge upwards along inner margin; notopleurals 1 + 1. All the Australian genera have the palpi very small, the eyes distinctly haired, and the first posterior cell of the wing open and terminating a little before wing tip.

The tribe containing *Cuphocera* Macquart, *Peleteria* Robineau-Desvoidy, *Archytas* Jaennicke, *Echinomyia* Latreille, and some other genera, although having the head similarly formed, even in some cases with the minute palpi, have the second antennal segment usually distinctly elongated, almost always longer than third segment, and the hind coxae haired above bases of femora.

There are three species amongst my Australian material, each apparently referable to a distinct genus. They may be distinguished as in the following key.

Key to the Genera.

1. Parafacials bare; frons of male about one-sixth of the head width at vertex, without strong forwardly directed supraorbitals ..... *Linnaemyia* Rob.-Des.
   Parafacials haired 2
2. Parafacials without strong bristle; frons in both sexes about one-third of the head width at vertex, and with at least two strong forwardly-directed supraorbitals on each side ..... *Chaetophthalmus* Brauer and Bergenstamm
   Parafacials each with one strong bristle (Text-fig. 17) ..... *Apalpus*, n. gen.

N.B.—The genus *Palpina* Malloch, from the Federated Malay States, has the parafacials bare, but it lacks discal bristles on second and third abdominal tergites, has the sutures of the tergites indistinct centrally, and a long appendix at the preapical bend of the fourth wing-vein. It most closely resembles *Linnaemyia*.

Genus Linnaemyia Robineau-Desvoidy.

I am placing in this genus one of the Australian species now before me, but it does not agree absolutely with the characters of the genotype, though it possesses most of its characters.

Linnaemyia bicolor (Macquart).

It is possible that I am in error in identifying this specimen as belonging to Macquart's species, but it agrees very well with his description and, without an opportunity to examine the type specimen of *bicolor*, it is not possible to be certain of its identity. I briefly describe the specimen to insure its recognition by others.

Male.—Head orange-yellow, frontal orbits, upper portions of parafacials and face, and the raised portions of cheeks white-dusted, upper half of occiput greenish-black, white-dusted, almost all of third antennal segment and entire aristae black; lower occipital hairs pale, all other cephalic hairs black. Thorax and abdomen fulvous testaceous, shining, the former with almost entire dorsum metallic blue-green, with whitish dusting, the mesonotum with four dark vittae, apex of

scutellum with a small fulvous spot; abdomen with the centre of first and second visible tergites very broadly metallic blue-green, third tergite not so broadly so, the dorsum slightly whitish-dusted. Legs fulvous testaceous, tarsi darker from near bases to apices. Wings greyish hyaline, yellowish at bases. Calyptrae whitish-yellow. Halteres yellow. Head in profile as Text-fig. 16; frons at vertex about one-sixth of the head width, widened anteriorly, inner verticals long, cruciate, outer pair lacking, ocellars well developed, orbits sparsely haired, parafacials bare. Thorax with 3 + 4 dorsocentrals, 3 + 3 acrostichals, three intra-alars, prealar long, scutellars 8, sternopleurals 2 + 1. Abdomen with very long discals and apicals on tergites 2 to 4 inclusive. Costal thorn almost as long as inner cross-vein; bend of fourth vein with a short appendage; outer cross-vein bisinuate.

Length, 8 mm.

Locality.—Gundamaian, Port Hacking, N.S.W., 22.8.1925 (A. Musgrave). Australian Museum.

Genus Apalpus, nov.

This genus is readily distinguished from all others of the tribe known to me by the presence on each parafacial of a strong bristle (Text-fig. 17). Propleura bare on the central portion; discal bristles present on third and fourth visible tergites. In the group containing *Peleteria* Robineau-Desvoidy there are a number of genera which have similar strong bristles on the parafacials, but in all of these the hind coxae are haired above bases of the femora as mentioned in a preceding paragraph.

Genotype, the following species.

Apalpus dorsalis, n. sp.

Female.—Head testaceous yellow, whitish-yellow-dusted, upper half of occiput fuscous, and grey-dusted, on each side; third antennal segment largely brown apically; aristae dark brown; hairs on frons, parafacials, and cheeks dark, those on entire occiput yellow. Thorax fuscous, broadly testaceous yellow on upper half of pleura and more narrowly along margins of mesonotum, especially on hind margin, the black dorsal portion lightly whitish-dusted, and indistinctly vittate. Abdomen shining, testaceous yellow, disc broadly bluish-black, with slight whitish dust, most noticeable on the fourth tergite, the margins only narrowly yellow. Legs yellow, apical four tarsal segments of fore and mid tarsi fuscous, basal two yellow on the only one of the hind legs remaining on type, the apical three broken off. Wings hyaline. Calyptrae and halteres yellow.

Eyes rather long pale-haired; frons at vertex fully one-third of the head width, widened to anterior margin; inner verticals long, outer pair undeveloped; orbits well defined, with strong bristles and fine black hairs, inner series of bristles (8-9) abruptly turned outward near base of antenna and extending almost to eye, outer forwardly-directed orbitals two in number; postverticals and ocellars weak; interfrontalia parallel-sided, anteriorly narrower than either orbit; parafacials with fine hairs and one strong bristle (Text-fig. 17). Thorax with 3 + 3 dorsocentrals and acrostichals, 1 + 1 or 1 + 1 + 1 sternopleurals, and some hairs below the lower calypter; postscutellum well rounded. Abdomen broadly ovate, sutures between tergites weak centrally, second visible tergite with a pair of central apical bristles, third with a pair on disc and a complete apical series, fourth with the discal series stronger than the apical series. Fore tarsus with the

apical four segments widened, the fifth least so; mid tibia with a median ventral bristle; hind tibia with four or five irregular anterodorsal and posterodorsal bristles. Third wing-vein setulose at base above and below; bend of fourth vein angular, with a short appendage, distance from bend to outer cross-vein not one-third as great as distance from that vein to inner cross-vein.

Length, 7 mm.

Type, Eradu, near Geraldton, W.A., Sept. 8, 1926 (Nicholson).

Submitted by Dr. I. M. Mackerras, to whom the type will be returned.

Genus CHAETOPHTHALMUS Brauer and Bergenstamm.

This genus was erected for the reception of two Australian species, of which *brevigaster* Macquart was selected as genotype. It was distinguished from the other genera accepted as belonging to the tribe by its authors by the much more strongly haired parafacials, and the broader abdomen. I have not detected any hairs on the parafacials of any genotype examined by me that pertains to those sunk as synonyms of *Linnaemyia*, but there may be some such that are unknown to me. Meanwhile I accept the Australian group as a valid genus.

I have only two examples of the genus before me, evidently the sexes of one species, though there is a considerable difference in the colour markings of the specimens. It may be that my specific identification is wrong, but the generic determination is almost certainly correct.

It must be noted in connection with this genus that *Aprotheca* Macquart was unknown to Brauer and von Bergenstamm when they erected it, and also that in my catalogue of this family there are some species which were retained in *Micropalpus*, one of them suggested as a possible *Chaetophthalmus* by these authors, but all of them unknown to them except from descriptions.

CHAETOPHTHALMUS BREVIGASTER (Macquart).

Male.—Head yellow, with yellow dust, somewhat changeable on parafacials, occiput fuscous on each side of upper half; third antennal segment brown on almost the entire outer half; aristae black; occipital hairs yellow, the other cephalic hairs fuscous. Thorax testaceous yellow, mesonotum except margins fuscous, with a blue tinge, whitish-dusted, and with four dark vittae; scutellum testaceous, with a fuscous tinge showing through from below. Abdomen fulvous testaceous, with a blue-black vitta occupying central third of dorsum up to middle of fourth visible tergite, the dust yellow on pale portions, whitish on the dark vitta. Legs yellow testaceous, tarsi slightly darkened apically. Wings hyaline, yellowish at bases. Calyptrae and halteres yellow.

Frons at vertex about one-third of the head width, each orbit with two or three strong forwardly-directed bristles laterad of the inner marginals; ocellars rather short, widely divergent; inner verticals long, outer pair undeveloped; profile as in Text-figure 18. Thorax with 3 + 3 dorsocentrals and acrostichals. Discals usually present on all tergites except first visible. Bend of fourth vein with an appendage.

Female.—Differs from the male in lacking a conspicuous dorsocentral vitta on the abdomen and in having the yellow dust more dense, especially on centre of basal half of dorsum.

Length, 6-7 mm.

Localities.—Male, Cairns, N. Queensland; female, Allyn Range, Barrington Tops, Feb. 25, on *Leptospermum* (Sydney University Zool. Exped.).

I know of no such sexual difference in colour in any other species of the group, and my assignment of both to the same species may be an error.

Tribe **Tachinini.**

The species following have been placed herein in groups under the names of the best known genera in each group, though some of these groups are possibly entitled to tribal status.

Gonia Group.

I have already, in my previous paper in this series, dealt with two genera of this group, *Tritaxys* Macquart, and *Anamastax* Brauer and von Bergenstamm. I now add some more genera to the group, figuring the heads of the new genera in profile so that a clearer conception of the genera may be obtained than would be possible merely from a description. In two of these genera the eyes are conspicuously haired, and in one of these only is the third notopleural bristle developed.

Genus Quadra, nov.

Generic characters.—Eyes bare; head in profile as Text-figure 19; facial ridges elevated, but not noticeably more so at vibrissae than elsewhere, setulose to past midway to bases of antennae; first posterior cell closed a little before attaining the wing margin; visible abdominal tergites 2 to 4 with discal bristles.

The closed first posterior cell of wing is a very unusual, if not unique, character in this group.

Genotype, the following species.

Quadra ornata, n. sp.

Female.—Head bright orange-yellow, with golden yellow dust, occipital hairs yellow, postocular ciliae and other cephalic hairs black. Thorax fuscous, the humeri, lateral margins of mesonotum except in front of suture, the sutures of pleura, and all of scutellum, testaceous yellow, the scutellum shining, the other portions with dense yellow dust, mesonotum densely grey-dusted on disc, and with four black vittae, all interrupted at suture, the submedian pair narrow, extending less than midway from suture to hind margin, the sublaterals much broader, extending about three-fourths of the distance from suture to hind margin. Abdomen black, densely coated with whitish-grey dust, dorsal exposure of first tergite shining black, second and third tergites each with a large shining deep black mark on each side, which are narrowly separated centrally and extend over lateral curve, the pair on second tergite extending to anterior margin, fourth tergite unspotted. Legs orange-yellow, tarsi black except base of first segment. Wings hyaline, yellow at bases. Calyptrae whitish-yellow. Halteres yellow.

Eyes bare; frons at vertex one-third of the head width, interfrontalia parallel-sided, at middle half as wide as either orbit, each orbit with long hairs and bristles, the latter in two series along inner margin anteriorly, the inner series curving outward below, and opposite apex of second antennal segment reaching midway to eye, two strongly forwardly-directed supraorbitals on each side; parafacials haired to lower level of eyes; third antennal segment slender, about five times as long as second; arista about as long as third antennal segment, almost

the same diameter to well beyond middle, second segment about as long as thick; palpi long, clubbed. Thorax with 3 + 4 dorsocentrals, and 3 + 3 acrostichals, the prosternum setulose, 2 + 1 sternopleurals, no extra notopleural, and five bristles on the presutural lateral area. Abdomen broadly ovate, a complete series of preapical bristles on third visible tergite, none on fourth. Legs normal, fore pair missing in type, hind tibia with the anterodorsal bristles very uneven. Third wing-vein with two bristles at base above and below.

Length, 11·5 mm.

Type, King George's Sound, W.A., no other data. Australian Museum.

I can find no description amongst those of the older authors that agrees with this conspicuously marked species.

Genus Zebromyia, nov.

This genus differs from the preceding one in having the eyes quite densely and noticeably haired, the first posterior cell of the wing open, no discal bristles on the second and third abdominal tergites, and apical bristles on first and second tergites, while there are only four bristles on the presutural lateral area of thorax, and the sternopleurals are 1 + 1.

Genotype, the following species.

Zebromyia obesa, n. sp.

Male.—Head reddish testaceous, with changeable white dusting, checkered on parafacials, frontal and postocular orbits; third antennal segment fuscous, paler at base; upper postocular orbits and ocellar region fuscous; occipital hairs whitish-yellow, postocular ciliae and other cephalic hairs black; palpi yellow. Thorax similar to the preceding species, but the pale parts more rufous, the disc of mesonotum not so dark, and the dark vittae nearly equal in width, more widely broken, and more punctiform behind suture. Abdomen with the dark marks on dorsum more transverse and not so dark in colour, almost castaneous, the fourth tergite with a pair of small blackish spots at apex. Legs entirely reddish testaceous. Wings yellow at bases. Calyptrae white. Halteres yellow.

Head in profile as Text-figure 20; frons at vertex about one-fourth of the head width, interfrontalia at middle about equal in width to either orbit, the latter with long hairs and bristles, the bristles descending well below level of apex of second antennal segment and nearly reaching eye; parafacials bare on lower two-thirds; facial ridges seen from the side almost as wide as parafacials, with four or five series of short black bristles, longest on section above vibrissae. Thorax with 3 + 4 dorsocentrals, 3 + 3 acrostichals, four bristles on presutural lateral area, the extra notopleural weak or lacking, and the sternopleurals 1 + 1. Abdomen broadly ovate, first and second visible tergites each with a pair of central apical bristles, third with a complete series on the black portions, fourth with long bristles on sides and apex and encroaching slightly on disc, sternal bristles not as long or strong as those on lateral edges of tergites. Fore tibia with bristles on basal three-fourths of anterodorsal surface; mid tibia with a ventral bristle; mid femur with about six strong bristles in two series at middle on anterior surface; anterodorsal series of bristles on hind tibia quite uneven, two or three of them outstanding. Third wing-vein with about three bristles at base above and below; first posterior cell open.

Length, 12-13 mm.

Type and one paratype, Tasmania, no other data. Australian Museum.

Genus Arrhenomyza, nov.

This genus belongs to the *Gonia* group, agreeing in all essential characters with my definition given in a preceding paper of this series, except in having the third notopleural bristle undeveloped. There are numerous long bristly hairs on the notopleural region in the male and, as it is not unusual for the female to have fewer and stronger hairs than the male, it is quite probable that in that sex the third notopleural may be distinct. The frons is exceptionally developed, extending well above upper level of eyes in profile (Text-fig. 21), and regularly convex when seen from in front; the orbits greatly exceed the interfrontalia in width and are entirely haired, connecting with the similarly haired parafacials; facial ridges bare; eye hairy; third antennal segment about twice as long as second; second aristal segment hardly longer than wide; proboscis hardly longer than head; palpi long, slightly club-shaped. Prosternum setulose; propleura bare in centre; metasternum haired. Abdomen with some bristles on second visible tergite which are apical laterally, and become preapical centrally, a similar series on third tergite which recede almost to middle of disc at centre, and no outstanding bristles on fourth tergite. Otherwise much as the other genera, but with only one bristle at base of third wing-vein, on upper side.

Genotype, the following species.

Arrhenomyza conspicua, n. sp.

Male.—Head orange-yellow, ocellar spot and a broad streak on lower portion of upper half of occiput black; occiput white-haired, postocular ciliae and other cephalic hairs black. Thorax deep black, with the following conspicuous white-dusted marks: a slender vitta along each series of dorsocentrals, connected at suture by a similar transverse line which is widened laterally and centrally, a spot on each humerus, and three smaller spots on lateral margins behind that, one before and one behind suture, and the other just in front of scutellum, and a spot on each pleural sclerite; scutellum translucent yellow, narrowly dark at base; spiracles yellow; all hairs black. First abdominal tergite black, second, third, and fourth, densely greyish-white-dusted, second with five black marks, a central spot, a large sublateral sub-triangular mark, and a large lateral spot, third with only three black marks, the sublaterals missing; fourth without black marks; hypopygium and sternites black, the lateral tergal spots glossy, the others less evidently shining. Legs orange-yellow. Wings hyaline, orange-yellow at bases. Calyptrae white. Halteres yellow.

Eyes haired; postocular ciliae long and fine; frons at vertex one-third of the head width, inner verticals not very strong, outer pair hardly distinguishable, ocellars weaker than postverticals, suberect and slightly divergent; interfrontalia at centre not one-third as wide as either orbit. Thorax with 3 + 4 dorsocentrals, 3 + 2 acrostichals, three posterior intra-alars, four bristles on the presutural lateral area, and some hairs on central upper portion of postalar declivity. Third and fourth visible abdominal tergites each with a dense patch of stiff short black hairs occupying almost all of the black patches on the lateral incurved portions. Hind tibia with the anterodorsal fringe of bristles longer than usual in this group, and with one outstanding anterodorsal bristle, the other bristles as in *Gonia*.

Length, 10 mm.

Type, Eradu, near Geraldton, W.A., 8.9.1926 (Nicholson).

It would appear worth noting that in this genus and *Quadra* we find a recurrence of the conspicuous black and white markings characteristic of the genus *Amphibolia*, of *Microtropeza ruficornis* Macquart, and *Amenia maculiventris* mihi, a type of coloration in that degree of prominence unknown to me in this family from any other region. The very striking white markings of such genera as *Rutilia* are also characteristic of this faunal region. No such features are found in the South American fauna, but there the number of genera in Calyptratae in which the abdomen is black with red, yellow, or golden apex is quite noteworthy, as are the two features mentioned above, but the occurrence is not restricted to that continent, though much more common there than in other regions. Another feature of the Australian tachinid fauna is the number of metallic blue or green species, and also the percentage of the family in which the eyes are very distinctly haired.

Genus Froggattimyia Townsend.

This genus and the next are distinguished from all the other genera included in Tachinini in this paper by the presence of erect hairs on the central portion of the propleura. There are very few Tachinini, and in fact very few genera of the family outside of the Ameniini, Rutiliini, and Dexiini, that have this character. Although especially noteworthy, it is remarkable that in the African representatives of the genus *Cylindromyia* Meigen there are species with, and without, the propleural hairs, one with hairs being now before me. In the Australian and North American species known to me the hairs are lacking.

Froggattimyia belongs near *Tritaxys* Macquart. In the genotype (*hirta* Townsend) the type specimen has the propleura yellow-haired in centre, the parafacials entirely haired, facial ridges bare, eyes bare, notopleurals 1 + 1, prosternum setulose, the abdomen without strong discal bristles, second segment of the arista not elongated, first posterior cell open, third antennal segment extending four-fifths of the distance to mouth margin and about four times as long as second segment.

I have seen only the type specimen in the United States National Museum.

Genus Protomeigenia Townsend.

This genus is very similar to the preceding one, but the antennae are a little shorter, the facial carina is the same (see key), but the parafacials are haired only down to about their middle.

The type specimen of the genotype (*aurea* Townsend) has the hairs on centre of the propleura black, but along with it there is a second specimen in which the hairs are pale yellow.

For localities of these species see my catalogue of the family.

Genus Gonia Meigen.

I have seen no Australian representative of this genus.

Chlorotachina Group.

This group, as accepted herein, contains metallic coloured species which have the eyes haired, the palpi well developed, aristae bare or almost so, strong discal bristles on the second to fourth visible abdominal tergites, the parafacials bare, and the lower calypter widened behind, without a bulge upward along inner margin.

In *Chlorotachina* the face is not carinate, but in *Macrochloria* there is a very distinct vertical carina on the upper half of face. *Chlorodexia* Townsend is a synonym.

Genus Chlorotachina Townsend (1915).

This genus was erected for the reception of a metallic green species with somewhat the appearance of a small slender *Rutilia*. The face, however, lacks the central carina, the eyes are hairy, the centre of the propleura is bare, the upper calypter is short and rounded at apex, and the fore tibia has an almost complete series of anterodorsal bristles. The hind tibia has an irregular anterodorsal series of bristles, two or three of them being much longer than the others, the prosternum is haired, and there are no hairs below the lower calypter, on the suprasquamal ridge, or on the centre of postalar declivity. Angle of fourth vein without a conspicuous appendage.

Genotype, *Chrysosoma flaviceps* Macquart.

The species at present known to me may be distinguished as in the key below.

Key to the Species.

1. Frontal orbits, entire face, and cheeks, bright golden-yellow-dusted; entire antennae bright orange-yellow; humeral angles when seen from behind with a conspicuous spot of dense white dust clearly differentiated from the adjoining mesonotal region; abdomen without any dusting 2

   Frontal orbits and a spot on parafacials densely white-dusted; face and cheeks brownish, changeably dusted; third antennal segment brown at apex; dorsum of thorax more densely and evenly dusted than in the preceding species, the dust on humeral angles when seen from behind not more conspicuous than that on adjoining mesonotal region; abdomen metallic green, with whitish-dusting, similar in appearance to that of *Lucilia sericata* Meigen .... *froggatti* Townsend

2. Thorax and abdomen metallic blue-green; fore tibia with the anterodorsal series of bristles complete ..... *flaviceps* (Macquart)

   Thorax black, with quite evident blue shade; abdomen glossy black, with purplish or bronzy tinge on sides basally; fore tibia with the anterodorsal series of bristles confined to basal third ..... *nigrocaerulea*, n. sp.

Chlorotachina flaviceps (Macquart).

A metallic blue-green species. Frons black, orbits, entire face, and cheeks golden yellow; antennae and palpi orange-yellow. Thorax noticeably white dusted on dorsum anterior to the suture, the humeri when seen from behind with a large white spot; the mesonotum with four dark vittae anteriorly. Abdomen without dusting. Legs black. Calyptrae white. Halteres fuscous.

Male.—Frons at vertex about one-fifth of the head width; parafacials bare below bases of antennae; epistome projecting; one or two bristles above vibrissae; aristae bare; palpi of moderate length. Thorax with 3 + 4 dorsocentrals, 4 + 3 acrostichals, and the sternopleurals 2 + 1. Visible tergites 2 to 4 with discal bristles, second with a pair of apical central bristles, third with a complete apical series, fourth with two such series.

Length, 10-11 mm.

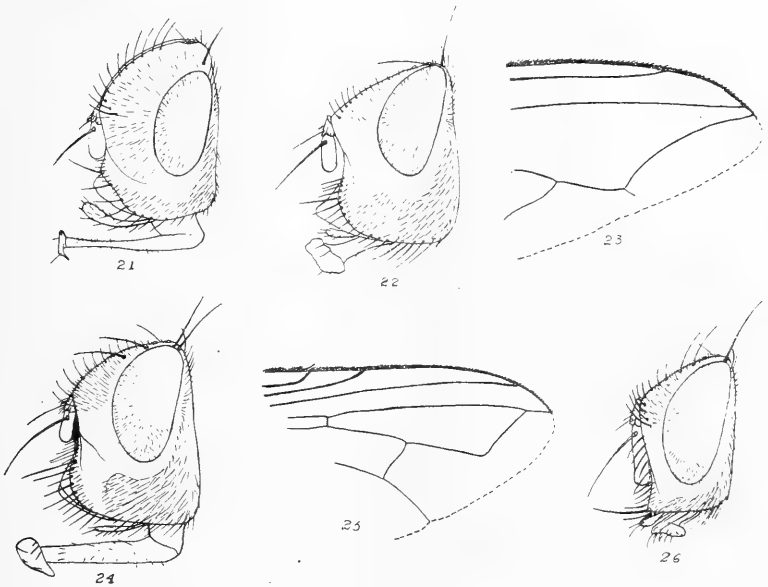
Locality.—Cairns, N.Q. (A. P. Dodd). Labelled "ex bark".

Chlorotachina nigrocaerulea, n. sp.

This may be merely a variety of *flaviceps*, from which it differs essentially in being largely glossy black, the thorax with a bluish cast, and the abdomen with a

purplish tinge on sides basally. The legs are black, the wings greyish hyaline, calyptrae white, and halteres fuscous.

Frons at vertex one-sixth of the head width in male, interfrontalia widened from back to front, orbits strongly bristled along entire inner margins anterior to ocelli, finely haired laterad of the bristles; ocellars rather long; inner verticals long, incurved, outer pair not developed; postocular ciliae long above; profile as in Text-fig. 22; parafacials bare. Thorax with 3 + 4 dorsocentrals, 4 + 4 acrostichals, five bristles on the presutural lateral area; the sternopleurals 2 + 1; and no hairs just below the lower calypter. Second and third visible abdominal



Text-fig. 21.—*Arrhenomyza conspicua*, head of male from the side.
Text-fig. 22.—*Chlorotachina nigrocaerulea*, head of male from the side.
Text-fig. 23.—*Chlorotachina nigrocaerulea*, apex of wing.
Text-fig. 24.—*Macrochloria calliphorosoma*, head of female in profile.
Text-fig. 25.—*Phorocerosoma setiventris*, apex of wing.
Text-fig. 26.—*Phorocerosoma setiventris*, head in profile.

tergites with two or three pairs of long discal bristles, third with a complete apical series, fourth with long bristles on disc and apex, sternites and lateral margins of tergites without strong bristles, but rather abundantly haired. Fore tibia with four or five short bristles on basal half of anterodorsal surface; mid femur with one median anterior bristle; mid tibia with a ventral bristle; hind tibia with 5 to 8 unequal anterodorsal bristles. Base of third wing-vein with about eight short fine closely placed setulae above and below; wings slightly pointed, apical venation as Text-fig. 23.

Length, 13 mm.

Type, King George's Sound, W.A., no other data. Australian Museum.

CHLOROTACHINA FROGGATTI Townsend.

Male.—Differs from the genotype in having the head much darker coloured, the frons largely fuscous, face dark brown above, raised portion of cheek metallic green, and third antennal segment brown at apex. The thorax and abdomen are metallic emerald-green, with white dusting.

Structurally the species are very similar, but the fourth visible abdominal tergite is less copiously bristled, and there is a noticeable appendage at angle of the fourth wing-vein.

Length, 10 mm.

Locality.—Blue Mts., N.S.W., 9.2.1915 (A. Musgrave). Australian Museum.

I have carefully compared this specimen with the type specimen and find that they agree in all particulars, thus *Chlorodexia* is synonymous with *Chlorotachina*, this being the genotype of the former.

Genus MACROCHLORIA, nov.

This genus is closely related to the foregoing one, but it differs radically in the structure of the head as can be seen by comparing the Text-figures 22 and 24 herein. The genotype has a very noticeable superficial resemblance to some of the large species of the genus *Calliphora*, hence the specific name. In addition to the distinction in head structure, the posterior sublateral bristle is lacking, and there are some hairs below the lower calypter.

Genotype, the following species.

MACROCHLORIA CALLIPHOROSOMA, n. sp.

Male and female.—Head reddish testaceous; frons fuscous, interfrontalia of female brown, orbits yellowish-grey-dusted, changeable; face yellow-dusted; occiput fuscous except below, with whitish dust; antennae reddish-yellow, third segment blackened apically; aristae fuscous; palpi reddish-yellow; genal hairs dark in front, pale behind. Thorax fuscous, with distinct blue tinge, dorsum whitish-dusted, with four narrow dark vittae which do not reach posterior margin. Abdomen metallic blue-green, dorsum without evident dusting, except on fourth tergite, where there is quite conspicuous white dust when seen from behind, venter white-dusted. Legs variable in colour, sometimes dark brown with fuscous femora, sometimes entirely fuscous. Wings greyish hyaline, yellowish at bases; basal scales rufous yellow. Calyptrae yellowish. Halteres yellow. Pleural and abdominal hairs dark.

Frons of male at vertex about one-tenth of the head width, vertical bristles hardly differentiated, ocellars lacking, orbits bulging up slightly in front, rather densely long-haired, the inner series strongest; frons of female at vertex about one-fourth of the head width, widened anteriorly, all four verticals strong, post-verticals lacking, ocellars very short and fine, orbits wide, exceeding interfrontalia except in front, with two strong forwardly-directed supra-orbitals, the inner series of moderate strength, and the surface short-haired to below bases of antennae; profile as Text-fig. 24. Thorax with 3 + 4 dorsocentrals, 3 + 3 acrostichals, three posterior intra-alars, three bristles on anterior lateral area, the posterior sublateral lacking, sternopleurals 1 or 2 + 1, prosternal plate with a few microscopic hairs, and about twelve marginal scutellars. Abdomen ovate, second and third tergites each with one or more pairs of discals, second with two or more apical bristles in centre, third with a complete apical series, fourth with long bristles on most

of dorsum. Fore tibia with the anterodorsal setulae very short, lacking in male; hind tibia with about three outstanding anterodorsal and posterodorsal bristles. Bend of fourth vein with short appendage.

Length, 12-14 mm.

Type, male, Barrington Tops, N.S.W., 20.1.1927 (T. G. Campbell); allotype, one male and one female paratype, Kosciusko, N.S.W., March, 1889 (Helms). Australian Museum.

The facial carina in this genus is quite pronounced, being rounded above to near the level of apices of antennae where it becomes obsolete, there being no evidence of it on the lower half of the face.

Phorocera Group.

The genera included in this group all have the facial ridges strongly bristled to well above the middle, the eyes more or less distinctly haired, third antennal segment longer than the second and extending well below middle of face, frontal bristles descending to below level of base of third antennal segment, parafacials bare below lower frontal bristle, ocellar bristles present, palpi well developed, prosternal plate haired or bristled, notopleurals 1 + 1, centre of propleura bare, posterior sublateral bristle present, hind coxae bare above bases of femora, fifth wing-vein distinctly shorter beyond than before outer cross-vein, first wing-vein bare, third with some setulae at bases above and below, lower calypter broad, not bulging up along inner margin.

The largest and most widely distributed genus is *Phorocera* Robineau-Desvoidy, which according to the most recent treatment contains several subgenera. Amongst my material from Australia there are two species which I consider are entitled to generic separation from any other of the group, and I describe them herein.

Genus Phorocerosoma, nov.

This genus is most closely related to *Madremyia* Townsend and *Murdockiana* Townsend, two monobasic North American genera in which the first posterior cell of the wing is closed at the margin and usually short petiolate. In both of these genera the outer cross-vein is situated more than twice as far from the inner one as from the bend of fourth vein, and the abdomen has discal bristles on the second and third visible tergites. There are no discal bristles on the second and third visible tergites in the new genus and the venation of the apical portion of wing is as Text-fig. 25. For other characters see description of genotype.

Genotype, the following species.

Phorocerosoma setiventris, n. sp.

Male.—Black, slightly shining. Interfrontalia dark brown, remainder of head densely white-dusted, almost silvery; antennae black, apex of second segment testaceous yellow; palpi testaceous yellow; hairs on lower occiput pale, other cephalic hairs black. Thorax quite densely pale-grey-dusted, mesonotum with four linear black vittae, sublateral pair interrupted at suture, all four ceasing between suture and hind margin; scutellum evenly grey-dusted. Abdomen densely grey-dusted, with a sub-triangular dark brown mark on centre of apical margin of each tergite and dots of same colour at bases of the hairs and bristles, ventral incurved portions of tergites almost all black, and distinctly shining. Legs black. Wings hyaline, yellowish at bases. Calyptrae white. Halteres dull yellow.

Head in profile as Text-fig. 26; frons at vertex more than one-fourth of the head width, orbits fully as wide as interfrontalia; ocellars short and fine; second segment of arista not longer than thick; eyes with very short sparse hairs. Thorax with 3 + 4 dorsocentrals and 3 + 3 acrostichals, 3 posterior intra-alars, the prealar long, sternopleurals 1 + 1 + 1, apical scutellars short and erect; prosternum with a few long bristly hairs. Abdomen with tergites 2 to 4 subequal, 2 with a pair of apical median bristles, 3 and 4 each with an apical series, the incurved lateral portions of 3 and 4 with quite dense decumbent short black hairs, but not with patches as in certain related species. Legs normal, the anterodorsal bristles on fore tibia very short, mid tibia with a ventral bristle, hind tibia with some outstanding anterodorsal bristles.

Length, 7 mm.

Type, National Park, Macpherson Range, Q., 18.12.1926 (A. Musgrave). Australian Museum.

There is no rearing record on this specimen, but as all the related genera are parasitic upon larvae of Lepidoptera, and to a lesser extent upon saw-fly and beetle larvae, it presumably has similar habits.

Genus Hillia, nov.

This genus has somewhat the same characters as the preceding one, but the first posterior cell of wing is closed nearer to the wing margin, the costal division between apices of auxiliary and first veins is much shorter (Text-fig. 27), the third vein is setulose on upper side to, or beyond, the inner cross-vein, the short erect apical pair of scutellar bristles is lacking, the frontal bristles do not descend below level of apex of the second antennal segment, and the posterior sublateral bristle of thorax is undeveloped. Like the preceding genus it has the hairs on the eyes very minute and sparse, appearing absent except under a high magnification (× 34).

Genotype, the following species.

Hillia polita, n. sp.

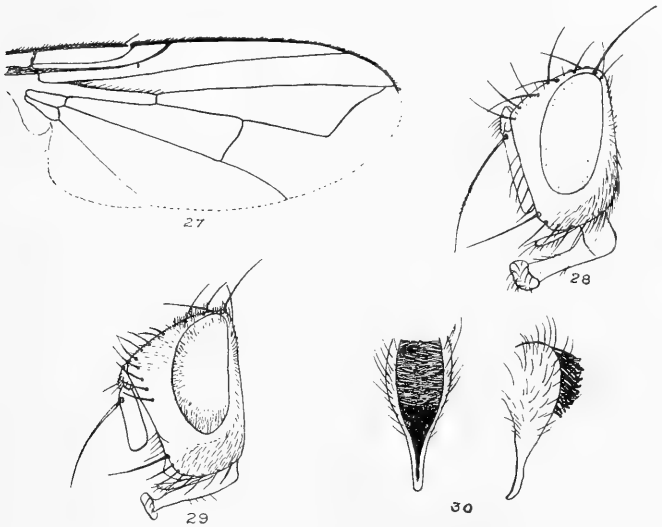
Female.—Black. Head with dense silvery dust on frontal orbits, parafacials, cheeks, and postocular orbits, upper portion of occiput slightly shining submarginally; antennae black; palpi testaceous yellow; lower occipital hairs pale. Thorax with quite dense whitish dust; mesonotum with two broad shining black vittae; scutellum black, contrasting with the grey-dusted postscutellum. Abdomen glossy black. Legs black. Wings greyish hyaline, yellowish at bases. Calyptrae white. Halteres fuscous.

Head in profile as Text-fig. 28; postverticals and outer verticals short, inner verticals long; ocellars moderately long; few orbital hairs present; third antennal segment extending almost to mouth margin, three times as long as second; arista microscopically pubescent, second segment not longer than thick. Thorax with 2 + 3 dorsocentrals, 3 + 3 acrostichals, prealar very short, sternopleurals 1 + 1, and a small bristle almost below the anterior one; scutellum with six marginal bristles, the median pair short; prosternum damaged in type. Abdomen with the tergites 2 to 4 subequal, second and third with a pair of strong median apical bristles, fourth with much shorter and weaker subapical and apical bristles. Anterodorsal surface of fore tibia with an almost complete series of rather

irregular anterodorsal bristles; hind tibia with the anterodorsal bristles irregular. Costal thorn longer than inner cross-vein.

Length, 4·5 mm.

Type, Darwin, N. Aust. (G. F. Hill).



Text-fig. 27.—*Hillia polita*, wing.
Text-fig. 28.—*Hillia polita*, head of female in profile.
Text-fig. 29.—*Thrycolyga sorbillans*, head of male in profile.
Text-fig. 30.—*Thrycolyga sorbillans*, hypopygial forceps from behind and the side.

Genus Phorocera Robineau-Desvoidy.

I have been unable to identify any Australian species of this genus satisfactorily. The few I have seen are quite normal in characteristics, but the species from New Zealand now before me differ from the typical Phorocerae in having the frons much broader, and with but one strong backwardly-curved upper orbital in the male. The males of typical species have two backwardly-curved bristles on the upper third of each orbit. The present is not an appropriate time to deal with the status of the New Zealand group.

There is a great number of Tachinidae involved in the division of the family to which *Phorocera* belongs, and much difficulty and uncertainty attend their generic elucidation. The principal generic concepts are *Phorocera*, *Zenillia* Robineau-Desvoidy (= *Exorista* auct.), *Exorista* Meigen (= *Tachina* auct.), *Frontina* Meigen and *Sturmia* Robineau-Desvoidy. The principal characters for the separation of these genera are the extent of bristling of the facial ridges, and the degree of hairiness of the eyes, both rather unsatisfactory for group distinction, because of the fact that it is not the absence or presence of either that is the criterion, but the degree of representation, thus making possible the occurrence of a large number of species which are hard to place in any group.

Frontina is very similar to *Phorocera*, the only character separating it therefrom being the indistinctly haired eyes. *Sturmia* is very similar to *Zenillia*, both

lacking strong bristles on the facial ridges except on their lower third or less, but the eyes in *Sturmia* are very indistincly haired, while those of *Zenillia* are quite conspicuously haired. The hind tibiae are stated to be pennate in both sexes in *Sturmia* while in *Zenillia* they are not so, or at least not so in the female, but this character does not hold in *Sturmia*, and in any case I consider it of much less than generic value. *Exorista* is about intermediate between the two groups, having the facial ridges setulose to, or slightly above, middle, and the eyes indistinctly haired. *Masicera* Macquart is close to *Sturmia*. For further discussion of the latter see subsequent page in this paper.

Genus Frontina Meigen.

I have seen one Australian species which apparently belongs to this genus, but am unable to determine what is the specific name for it if it has been described.

The genus is difficult to distinguish from *Phorocera*, the only character of any importance for that purpose being the indistinctly haired eyes. I have examined the genotype, *laeta* Meigen, and find, in addition to the generally cited characters, the following: prosternum setulose, no infrasquamal hairs, posterior sublateral bristle present, discals on second and third visible abdominal tergites of abdomen, hind tibia with an irregular fringe on anterodorsal surface.

Frontinella Townsend is similar, but has no discal bristles on second and third visible tergites of abdomen.

Exorista Group.

Genus Exorista Meigen.

This genus has generally been called *Tachina* by authors, but the latter name is now applied to the group more generally known as *Echinomyia* Latreille.

I have seen at least one Australian species which I cannot determine specifically at this time.

Genus Sturmia Robineau-Desvoidy.

I have seen a few species from Australia that would fall in this genus as generally accepted, but I am unable definitely to identify most of them specifically at this time. One species I discuss below.

Sturmia elzneri (Townsend).

This species was originally described as the genotype of *Ugimeigenia* by Townsend, but I can see no reason why it should be separated from *Sturmia, sens. lat.* It agrees in practically all the essential generic characters with the species generally accepted as belonging to this genus, except in the lack of ocellar bristles, which character in itself is not sufficient to justify generic separation, in my opinion.

A very strikingly coloured species. Black, the head and thorax covered with dense yellow, almost golden, dust; interfrontalia and antennae black; palpi yellow; dorsum of thorax with four deep black vittae, the pairs quite close together, the outer one of each extending farther posteriorly than the inner, but not attaining the posterior margin; scutellum black on the basal half; pleura more greyish-dusted below and behind. Abdomen black, slightly shining, bases of tergites densely and rather broadly white-dusted. Legs black, fore femora densely yellowish-

grey-dusted on posterior side. Wings greyish hyaline. Calyptrae yellowish-white. Halteres yellow.

Female.—Outer verticals undeveloped, ocellars indistinguishable from the long hairs, each orbit with two strong outer forwardly-directed bristles, orbitals descending to below level of apex of second antennal segment; third antennal segment about four times as long as second; palpi long; arista subnude, second segment not elongated. Prosternum setulose; dorsocentrals and acrostichals 3 + 4, posterior sublateral present, sternopleurals 2 + 1. Abdomen without discals or central apicals on tergites 1 and 2, 3 and 4 each with apicals. Hind tibia with one strong bristle in the regular anterodorsal fringe. Wing normal.

Length, 12 mm.

Locality.—Cairns, N.Q., ex scrub (A. P. Dodd). Originally described from Banks Island. Specimen compared with type.

It would appear to be worth noting that *Sturmia sericariae* Cornalia, the very widely distributed silk-worm parasite, agrees in practically all characters with the present one, lacking only the outstanding anterodorsal bristle on the hind tibia and having the third antennal segment rather shorter. It was placed in another genus and if that were valid it would carry with it *elzneri*, but Bezzi places *sericariae* in *Sturmia*. The latter species may be found to occur in Australia.

Genus Zenillia Robineau-Desvoidy.

This genus, generally called *Exorista* by authors, is very similar to *Thrycolyga* Rondani, the only character for their separation being that cited in my key, which is not by any means a satisfactory one, in my opinion, for distinguishing genera. However, the matter may rest pending a survey of the Australian forms. I have seen some unidentified species of *Zenillia* from Australia.

Genus Thrycolyga Rondani.

This generic name has been emended to *Tricholyga*, but the above is the original spelling.

I have before me one species of this genus from Australia and summarize the generic characters therefrom.

Eyes distinctly haired; frons of male with two strong backwardly-directed upper orbitals on each side, lower orbitals incurved and descending to middle of the parafacials; profile of head as in Text-figure 29; ocellars proclinate and slightly divergent, rather long; inner verticals long, outer pair undeveloped. Prosternum haired, centre of propleura and upper metapleura bare, notopleurals 1 + 1; lower calypter large, subtransverse at apex, raised along inner side near margin. First wing-vein bare, third setulose at base above and below, ending well before apex of wing; first posterior cell open. Hind tibia with a short anterodorsal fringe and one outstanding median bristle in the series.

Thrycolyga sorbillans (Wiedemann).

A black species, with dense whitish-grey dust, the thorax with four black vittae, and the abdomen with broad black apices to tergites. Wings clear. Legs black. Calyptrae white. Halteres brown.

A striking peculiarity of the species, and one distinguishing it from others of the genus, is the presence of dense, somewhat flattened pale yellow hairs on the hind sides of the basal portions of the superior hypopygial forceps of the male (Text-fig. 30).

Length, 10-12 mm.

Locality.—Cairns, N.Q., ex *Doleschalia australis* (A. P. Dodd).

The species is very widely distributed as a parasite of Lepidoptera, occurring throughout Europe, the Orient, and in Africa. It has also been introduced into the United States of America.

Synonyms of the genus are *Podotachina* Brauer and Bergenstamm, and *Neoscotia* Townsend, the latter having this species as its genotype.

Genus Winthemia Robineau-Desvoidy.

I have seen no species of this genus from Australia, but have no doubt that there are some such.

In the common North American species *quadripustulata* Fabricius, the eyes are conspicuously haired, the male has no strong upper reclinate orbitals, the hind tibia is evenly fringed in the male and in the female there is one outstanding bristle in the series, the posterior sublateral bristle is present, and there are no discal bristles on the second and third visible tergites of abdomen.

The next two genera I have not assigned to any particular group.

Genus Demoticus Macquart.

I have seen no species of this genus from Australia, the characters cited in the key to genera being derived from the genotype, *plebeius* Fallen, a European species. Curran is the only author recording the genus from Australia.

A summary of the generic characters is as follows: Eyes bare, facial ridges with a few hairs just above vibrissae, parafacials bare; prosternum bare; third antennal segment extending nearly to mouth margin, slightly widened at apex and about three times as long as second; arista bare; posterior sublateral bristle lacking; first posterior cell of wing open; discal bristles on second and third visible tergites of abdomen; hind tibia with an irregular series of anterodorsal bristles; orbits with forwardly-directed outer bristles in both sexes; second segment of arista elongated in male (two and a half times its own length), not elongated in the female.

Genus Semisuturia Malloch.

I have already dealt with this genus in this series of papers, reference to the paper being given in my catalogue of the family.

The present opportunity is taken to give a figure of the head of the female of the Australian species to show the characters of the genus (Text-fig. 31).

I have seen no further material belonging to the genus since writing my previous paper.

Euthera Group.

Some authors would consider this genus entitled to tribal rank, but I am not inclined to consider it so, though it has some rather striking characters which distinguish it from other Tachinidae.

Genus Euthera Loew.

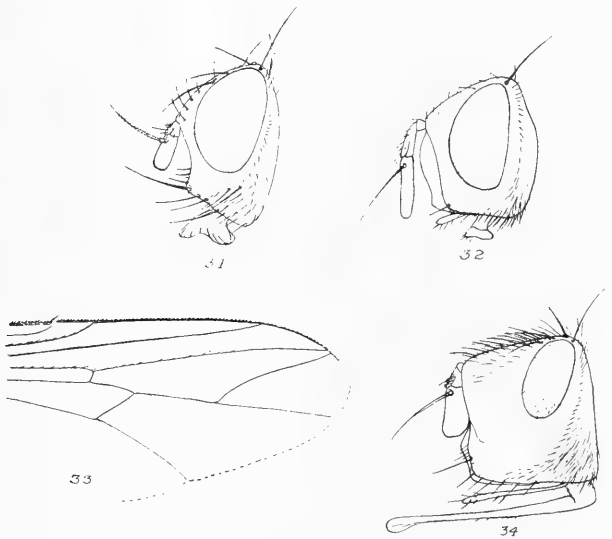
In some manner I failed to include this genus in my original manuscript of the catalogue of Tachinidae.

Bezzi dealt with all the species of the genus in 1925 (These Proceedings, 50, pt. 3, p. 275), and accepted three subgenera, one of them being erected in his paper. It is possible that these segregates may yet be accorded full generic status.

The single Australian species, *skusei* Bezzi, was placed in the subgenus *Macreuthera*, which subgenus agrees more nearly with typical *Euthera*, all the species of which are from the New World, than it does with the subgenus *Eutheropsis* Townsend, the species of which occur in Africa, Europe and Asia. *Eutheropsis* has the parafacials haired, the other two subgenera have them bare.

I have not seen the Australian species which, like all the others, has the wings very conspicuously marked with black. The species was described from a single female specimen collected at Eidsvold, Queensland, and ought to be in the collection of the Department of Public Health in Sydney, if it was ever returned by Dr. Bezzi.

I figure the head of *Euthera tentatrix* Loew, the genotype of *Euthera, sens. str.*, an American species (Text-fig. 32).



Text-fig. 31.—*Semisuturia australis*, head of female in profile.
Text-fig. 32.—*Euthera tentatrix*, head of female in profile.
Text-fig. 33.—*Hyleorus furcatus*, apex of wing.
Text-fig. 34.—*Peremptor vittata*, head of male in profile.

Voria Group.

This group is readily distinguishable from the others by the position of the outer cross-vein of the wing, which is at or before a point midway from inner cross-vein to bend of fourth vein, and the consequent lengthening of the ultimate section of fifth vein, which is at least half as long as the penultimate section, and frequently about as long as it. There are certain other groups in which this feature is present, but none of them is represented in available Australian material. Two closely related genera are amongst the material I have before me from New Zealand.

Genus Hyleorus Aldrich.

This genus has the eyes haired, facial ridges with bristles to above the middle, arista not as long as third antennal segment, its second segment about three times as long as thick, each orbit of the female with three strong forwardly-directed bristles, parafacials bare, all abdominal tergites from second visible to fourth with at least two strong discal bristles; first and third wing-veins setulose, the latter with hairs almost to apex; venation of apical half of wing as Text-figure 33.

Length, 5·8 mm.

I have examined the genotype and only species in the United States National Museum.

Tribe **Palpostomini.**

I have not received any recent material in this tribe so am unable to extend my notes upon it.

Tribe **Actiini.**

Genus Actia Robineau-Desvoidy.

I have just discovered an example of a species of this genus which appears to be new and is not included in my previous paper referred to herein.

Actia darwini, n. sp.

Male.—Head testaceous yellow, upper occiput fuscous on each side, densely grey-dusted, vertex, ocellar triangle, and frontal orbits dark, densely pale-grey-dusted, interfrontalia with pale dust when seen from certain angles, when seen from above and behind sharply differentiated in colour from the orbits; face and cheeks whitish-dusted; third antennal segment almost entirely yellowish-brown; palpi testaceous yellow. Thorax fuscous, densely grey-dusted, mesonotum not vittate; margin of scutellum slightly yellowish. Abdomen shining testaceous yellow, with a black dorsocentral vitta, black apices to third and fourth tergites, and a narrow fascia of white dust on each tergite. Legs testaceous yellow, apices of mid and hind femora, the hind tibiae, and mid and hind tarsi, more or less evidently browned. Wings hyaline. Calyptrae white. Halteres yellow.

Frons at vertex one-third of the head width, either orbit at middle as wide as interfontalia at same point, bristled as usual, lowest bristle above level of apex of second antennal segment, one or two fine hairs below it; parafacial visible in profile; third antennal segment simple, about three times as long as second, extending almost to mouth margin; second aristal segment about three times as long as thick, third tapered on apical half, subnude; palpi slightly club-shaped; apical section of proboscis as long as third antennal segment. Thorax with three pairs of postsutural dorsocentral bristles, lower stigmatal bristle represented by a short hair, lower sternopleural very short, no hair on anterior upper angle of hypopleura. Abdomen ovate, second visible tergite with a pair of median apical bristles, third and fourth each with six apical bristles. Mid tibia with an anterodorsal bristle near middle. Venation similar to that of *eucosmae* Bezzi, but the fourth vein is evident though weak from beyond the preapical bend to apex, first vein setulose on entire length above and at apex below, third vein setulose to a little beyond level of outer cross-vein above and with one setula at base below, fifth vein setulose along basal half of discal cell; inner cross-vein at middle of discal cell; ultimate section of fifth vein subequal to penultimate section.

Length, 3 mm.

Type, Darwin, N.Aust., 11.10.1916 (G. F. Hill).

This is the only Australian species I have seen which has the first, third, and fifth veins setulose above. There are a number of similarly armed species in the Orient, but none of them agrees with this one in all particulars.

Miscellaneous Genera.

The notes under this heading refer to genera not included in the generic key.

Genus ZITA Curran.

It is impossible for me to place this genus in my key owing to lack of mention of certain characters in the original description. It falls in the section with hairs on centre of propleura, and the pubescent arista would place it in the vicinity of *Rutilia*. though its being compared with *Arctophyto* Townsend indicates that it is not at all related to that genus. From all of the *Rutilia* group it is distinguished by the weak facial carina which is present only on the upper portion of face, but without information as to whether the face is deeply excavated and the suprasquamal ridge setulose it is impossible to place it in the key.

ZITA AUREOPYGA Curran.

This, the only species of the genus, should be readily distinguished by the densely golden-yellow-dusted head, yellow antennae, blackish palpi, black thorax with grey dust, four dark vittae, and two silvery pleural spots, the black abdomen with paired silvery spots on tergites 2 and 3, and golden dusted fourth tergite and hypopygium.

Length, 12 mm.

Locality.—Herberton, Q.

Type in Deutsches Entomologische Institut, Berlin-Dahlem.

Genus DODDIANA Curran.

This genus is compared with *Hyalurgus* Brauer and Bergenstamm by its describer. It has the prosternal plate and centre of the propleura bare, second and third antennal segments of almost equal length, the arista pubescent, second segment short, palpi long, posterior sublateral bristle absent, first posterior cell of wing open, first vein bare, outer cross-vein nearer to bend of fourth than to inner cross-vein.

DODDIANA PALLENS Curran.

This is the only species of the genus so far described.

Locality and location of type as in the preceding species.

Genus PALIA Curran.

Belongs to the *Phorocera* group, but has no ocellar bristles, and the two upper orbitals in the male are reclinate.

Monobasic, genotype, *Palia aureocauda* Curran.

Locality.—Kuranda, Q.

Genus PALIANA Curran.

Belongs to the *Phorocera* group, lacks the ocellars as *Palia*, but has only one upper reclinate bristle on each orbit. Not the same as the New Zealand group.

Two species. Genotype, *Paliana basalis* Curran.

Locality.—Kuranda, Q.

Genus Amplipila Curran.

Compared with *Winthemia* Robineau-Desvoidy by its describer, and stated to differ in lacking ocellar and posterior sublateral bristles, as well as in having shorter antennae and vibrissae above mouth margin. Genotype, *A. versicolor* Curran.

Locality.—Herberton, Q.

Synoptic treatment of the Genera.

In presenting the subjoined partial key to the genera of Australian Tachinidae, I realize that there are some drawbacks to my doing so, one of the most serious of which is its incompleteness, there being only fifty-three genera included. This number may appear very inadequate, as compared with the total of eighty-eight in my recent catalogue, which in itself is incomplete, but there is considerable uncertainty regarding the status of many of the species referred to such genera as *Masicera*, *Tachina*, *Exorista*, etc., that I am undecided upon the propriety of including these genera in the key. There are also many genera which are unknown to me, including ten of those erected by Townsend for the reception of species described by the older authors, six erected by Brauer and Bergenstamm, fourteen of Macquart's genera, and six recently erected by Curran; these, with three synonyms, account for most of the missing genera.

I have, in the following key, discarded some of the characters generally used in generic synopses of the family, as I have in my own work found it practically impossible to decide which category certain species should be assigned to when one finds a division thus: "First posterior cell ending at or close to the extreme wing tip" as against "First posterior cell ending some distance before extreme wing tip" or "Vibrissae on a level with oral margin" as against "Vibrissae distinctly above oral margin". I do not consider that such divisions can be used by anyone because of their variability and the gradual merging from one to the other, nor do I believe that they indicate relationships. Colour I consider valueless in generic distinctions, though there are cases where colour and structure are invariably coordinated. In most keys one finds sections divided upon the criteria "Eyes hairy" and "Eyes bare". But working, as I do, with a uniform magnification of thirty-four, it is confusing to find that genera which are definitely located in the groups with bare eyes really have hairs on the eyes, short it is true, but nevertheless hairs. I have thus in my key stated more clearly than is customary just what is intended by "haired" and "bare" eyes.

In presenting these data I include also a number of figures which, though diagrammatic, may suffice as guides to the identification of the included genera. This precaution is taken because there must be many genera unknown to me that will run down more or less satisfactorily to certain of those included in the key, and still be readily distinguished from those on the basis of characters not mentioned in this paper. I frequently include in my captions characters that are not strictly diagnostic, but do so for the purpose of distinguishing the genera, not from those they are compared with in the key, but from others, unknown to me, which may conceivably run down to the same captions on the basis of the primary distinguishing character utilized therein, and yet differ in such subsidiary uncontrasted characters as are cited.

The genera preceded by an asterisk (*) are those as yet unrepresented in the material I have seen from Australia, though recorded by one or more of the older authors, except in the case of a few New Zealand genera, and possibly occurring

there. All such genera are included on the basis of genotype examination. Quite a number of the genera are not in material that is returnable to Australia, some belonging to the United States National Museum, so that all will not be available at this time to Australian students in my identified series which I hope to transmit to the Australian Museum very shortly.

Most of the genotypes examined are in the collection of the United States National Museum and were made available to the author by the curator, Dr. J. M. Aldrich.

I take this opportunity to deal with a quite remarkable new genus which occurs in New Zealand. It is not probable that it occurs also in Australia, but this is the first time an extensive key to the genera from this general region has appeared and it offers an opportunity to present comparative data which may prove of value.

Key to the Genera.

1. Propleura haired in centre* 2
   Propleura bare in centre 13
2. Postscutellum not prominently projecting, subtransverse, and slightly emarginate centrally at apex, with the heavily chitinized portion not carried far forward above; arista long plumose; all the abdominal sternites quite broadly exposed and armed with strong apical spines; hind coxae with hairs above bases of femora (Ameniini) 3
   Postscutellum prominently projecting, evenly, or sometimes rather sharply, rounded at apex, the chitin extending well over the dorsal exposure towards base; arista bare, pubescent, or short haired, if with distinct hairs the intermediate abdominal sternites are almost entirely concealed, and not strongly spinose; hind coxae bare above bases of femora except in *Microtropeza* Macquart 5
3. Face not carinate ..... *Paramenia* Brauer and Bergenstamm
   Face with a prominent central vertical carina 4
4. Frons in both sexes about one-third of head width, and with strong forwardly-directed supraorbital bristles; third antennal segment about as long as height of cheeks ..... *Stilbomyia* Macquart
   Frons of male much narrower than that of female and without forwardly-directed supraorbitals; third antennal segment much shorter than height of cheek ..... *Amenia* Robineau-Desvoidy
5. Supraspiracular (metapleural) convexity with long erect hairs; abdominal sternites rather broadly exposed and strongly spinose apically; face not carinate; arista bare; third antennal segment not much longer than second; apices of second and third wing-veins more closely approximated than usual (Text-figs. 1 and 2) (Microtropezini) ..... *Microtropeza* Macquart
   Supraspiracular convexity without distinct hairs; abdominal sternites usually concealed, if exposed they are not strongly spinose apically 6
6. Face not deeply sunken, with a very prominent central vertical carina which is on at least a part of its extent more or less broadly rounded and projecting beyond parafacials in profile (Ruteliini) 7
   Face deeply sunken, with a low linear central vertical carina which is not visible in profile (Tachinini, pt.) 12
7. Suprasquamal ridge with setulose hairs 8
   Suprasquamal ridge without hairs 10
8. Second and third visible tergites of abdomen with strong discal bristles ..... †*Paramphibolia* Brauer and Bergenstamm, *Amphibolia* Macquart, *Chaetogastrina*, n. gen.
   Second and third visible tergites of abdomen without strong discal bristles 9

* Some extralimital species of *Cylindromyia* have the propleura haired in centre, but these all have the hind margin of thorax above the coxae and below base of abdomen heavily chitinized, high, and vertical, which is never the case in any of the genera included in Caption 1 in this key.

† See prior treatment of these genera in this paper.

9. Facial carina narrowly rounded above, abruptly decreasing in height above middle of face, almost sharp below; parafacials with rather long coarse hairs to below lowest level of eyes; forwardly-directed supraorbitals of female exceptionally strong for this tribe ..... *Chrysopasta* Brauer and Bergenstamm.

Facial carina broadly rounded, sometimes more or less sulcate centrally, flat below; parafacials haired or bare; forwardly-directed supraorbitals present or absent; strong only in the subgenus *Senostoma* ..... *Rutilia* Robineau-Desvoidy

10. Palpi very small, not, or very little, longer than diameter of apical section of proboscis; upper calypter almost as long as the lower one ..... *Prodiaphania* Townsend

Palpi long, much longer than diameter of apical section of proboscis; upper calypter much shorter than lower one 11

11. Second and third visible tergites of abdomen without discal bristles ..... *Formosia* Guérin

Second and third visible tergites of abdomen with discal bristles ..... *Chaetogaster* Macquart

12. Parafacials haired on their entire extent ..... *Froggattimyia* Townsend

Parafacials haired down to about middle, bare below .... *Protomeigenia* Townsend

13. Abdominal tergites without strong dorsal bristles; ovipositor of female with a strong backwardly-directed spike-like or scoop-like process; frons of female without forwardly directed supraorbitals (Phaniini) 14

Abdomen with well developed macrochaetae at least at apices of tergites 3 and 4 15

14. Antennae as long as face; abdomen prominently convex above, sutures subobsolete, apparently immovable ..... **Gymnosoma* Meigen

Antennae about half as long as face; abdomen flattened above, sutures normal .... *Hyalomyia* Robineau-Desvoidy

15. Thoracic region above hind coxae and below base of abdomen entirely chitinized, slightly rounded, quite high and vertical (Cylindromyiini) ..... *Cylindromyia* Meigen

Thoracic region above hind coxae and below base of abdomen membranous (soft) centrally, usually rather low 16

16. Outer cross-vein of the wing not nearer to bend of fourth vein than to inner cross-vein 17

Outer cross-vein of wing very distinctly nearer to bend of fourth vein than to inner cross-vein 22

17. First vein bristled above, third setulose or bristled above and below at base 17*a*

First vein bare above, third setulose at base above and below 18

17*a*. Facial ridges bristled to above middle; parafacials bare below; ultimate section of fifth vein almost as long as penultimate, the venation apically as in Text-fig. 33, the bend of fourth vein with a continuation of that vein to, or almost to margin of wing ..... *Hyleorus* Aldrich

Facial ridges with one or two short bristly hairs above the vibrissae; parafacials with a complete series of strong downwardly-curved strong bristles; ultimate section of fifth vein about four-fifths as long as penultimate section in male, the bend of fourth vein with a short thick appendiculate vein which does not nearly reach the margin of wing (New Zealand) ..... **Calcageria* Curran

18. Scutellum with a number of long erect bristles on disc; distance from apex of second vein to apex of third not less than that from apex of latter to tip of wing, the first posterior cell of wing open; third antennal segment very little longer than second; prosternum bare (New Zealand) ..... **Calcager* Hutton

Scutellum without long erect discal bristles, if any long bristles are present they are decumbent and directed apically; distance from apex of second vein to apex of third very much greater than distance from apex of third to wing tip, if not very much greater the first posterior cell is closed and short petiolate 18*a*

18*a*. Lower calypter narrow, evenly rounded at apex, and well separated from the scutellum along its inner margin (Palpostomini) 19

Lower calypter broadened apically, apical margin broadly rounded or subtransverse, the inner margin adhering quite closely to the scutellum on most of its extent 20

19. First posterior cell of wing closed and with a more or less pronounced petiole .... *Palpostoma* Robineau-Desvoidy

First posterior cell of wing open ..... *Eustacomyia* Malloch

20. First posterior cell of wing open, sometimes the fourth vein evanescent or lacking beyond the preapical curve; facial ridges setulose on not more than their lower third (Actiini) ..... *Actia* Robineau-Desvoidy
First posterior cell of wing closed and with a more or less developed petiole; facial ridges with quite strong bristles on lower two-thirds or more (Tachinini) .. 21
21. Third wing-vein setulose less than midway from its base to inner cross-vein .... *Phorocerosoma*, n. gen.
Third wing-vein setulose from its base to, or beyond, inner cross-vein .. *Hillia*, n. gen.
22. Proboscis very slender, the apical portion at least three times as long as head; arista plumose; face with a complete, flattened, central vertical carina; abdomen without discal bristles on second and third visible tergites; parafacials and prosternum bare (Dexiini) ..... *Prosena* St. Fargeau and Serville
Proboscis normal, not, or but little, longer than head, if about twice as long the arista is almost bare 23
23. Palpi rudimentary or extremely short, not, or very little, longer than diameter of apical portion of proboscis (Linnaemyiini) 24
Palpi long, usually much longer than diameter of apical portion of proboscis, if subequal to it the proboscis is short and stout (Tachinini) 26
24. Parafacials bare ..... *Linnaemyia* Robineau-Desvoidy
Parafacials haired 24
25. Parafacial without a strong bristle ... *Chaetophthalmus* Brauer and Bergenstamm
Parafacial with a strong bristle near lower margin of eye ..... *Apalpus*, n. gen.
26. Face with a central vertical carina which frequently projects beyond parafacial in profile 27
Face without a well developed central vertical carina 29
27. Arista plumose; antennae short, about half the length of face; facial carina sharp; parafacials bare; prosternum bare; discal bristles on second and third visible tergites of abdomen; eyes bare; about one and a half times as high as cheek; posterior sublateral bristle lacking (Dexiini) ..... **Dexia* Meigen
Arista bare or almost so; other characters not as above in combination 28
28. Eye narrower than parafacial and not, or very little, higher than cheek; face with a deep cavity for the reception of the antennae when retracted, the foveae divided by a linear vertical carina which becomes higher and much wider below, filling the space between facial carina and sometimes visible from the side just above vibrissae as shown in Text-fig. 34; proboscis more slender than usual and its apical section longer than head; first posterior cell of wing open; eyes distinctly haired (New Zealand) ..... **Peremptor* Hutton
Eye wider than parafacial and higher than cheek; other characters not as above in combination 28*a*
28*a*. Facial carina broad, rounded, highest point at middle of face, antennae extending to, or a little below, mouth margin; first posterior cell of wing closed at some distance from margin of wing, the petiole quite long; eyes bare; discal abdominal bristles weak or undeveloped ..... *Euthera* Loew.
Facial carina almost nose-like, confined to upper half of face; first posterior cell of wing open; eyes distinctly haired; second and third visible tergites of abdomen each with more than one pair of strong discal bristles .... *Macrochloria*, n. gen.
29. No evident divisions between the tergites of abdomen on most of the dorsum, centrally apparently immovable; arista with very short hairs; parafacials narrow, bare; eyes very sparsely short haired ..... *Semisuturia* Malloch
Divisions between the abdominal tergites distinct, all capable of movement 30
30. Parafacials without fine hairs below middle, rarely with any below level of apex of second antennal segment; sometimes the strong frontal bristles descending beyond that point 31
Parafacials with fine hairs below middle, usually to lowest level of eyes 40
31. Lower calypter with quite long hairs on almost the entire upper surface; first posterior cell of wing open; discal bristles lacking on second and third visible tergites ..... **Nemoraea* Robineau-Desvoidy
Lower calypter without evident hairs except along margins, none on the disc ... 32
32. Arista long haired, the longest hairs at least as long as width of third antennal segment; first posterior cell narrowly open, ending rather close to wing tip .. 32*a*
Arista bare, pubescent, or very short haired, the longest hairs never appreciably longer than its basal diameter; legs stouter and shorter, the hind tibia with more numerous and longer bristles 33

32*a*. Slender species, with much the same habitus as *Cylindromyia* Meigen, the second and third visible tergites of abdomen each with a pair of long discal bristles; legs slender, and rather long, the hind tibia with one anteroventral, two anterodorsal, and two posterodorsal bristles, all short ... *Mesembriomintho* Townsend

Stouter species, without discal bristles on the second and third visible tergites of abdomen; legs not so slender nor long, the hind tibia with equally short bristles, but not arranged as above ..... *Rhinomyiobia* Brauer and Bergenstamm

33. Facial ridges broadly visible almost up to bases of the antennae when the head is viewed from the side, almost as wide as the parafacials, and furnished with about four irregular series of short stiff black hairs on more than three-fourths of their extent; frontal bristles extending to below level of apex of second antennal segment, ending close to eye (Text-fig. 20) ..... *Zebromyia*, n. gen.

Facial ridges much narrower and less extensively visible in profile, with one, rarely two series of hairs or bristles 34

34. Eyes densely and distinctly haired, the hairs visible with a weak magnification (× 10) 35

Eyes with very short sparse hairs, appearing bare except under a strong magnification (× 34); frontal orbits in male each with two strong backwardly-directed bristles on upper third 37

35. Facial ridges in profile narrowly visible on a variable portion of their extent, and with a series of quite strong bristles to well above middle; frontal orbit in male with two strong backwardly-directed bristles on upper third .... *Phorocera* Robineau-Desvoidy

Facial ridges in profile visible for only a short distance above vibrissae and with setulose hairs on bristles on less than their lower half 36

36. Frontal bristles extending in a single strong series along middle of parafacial sometimes to about midway to vibrissa; male with two strong backwardly-curved bristles on upper third of each frontal orbit; black species 36*a*

Frontal bristles usually confined to the inner margin of orbits, not descending below level of apex of second antennal segment; no strong backwardly-directed bristles on upper third of orbits in male; metallic blue or green species .... *Chlorotachina* Townsend

36*a*. Bend of fourth vein without trace of an appendiculate vein .... *Zenillia* Robineau-Desvoidy

Bend of fourth vein with a distinct appendiculate vein ..... *Thrycolyga* Rondani

37. Arista with quite evident hairs, the longest almost as long as its basal diameter; slender species; fourth visible abdominal tergite in male with a dense clump of black bristly hairs on each side below which are quite long apically and project slightly behind (Dexiini) ..... *Zosteromeigenia* Townsend

Arista bare or almost so; more robust species; male without the above-described anal tufts, though in some cases with patches of short erect hairs on same portions of third and fourth visible tergites 38

38. Facial ridges bristled to, or slightly above, middle, the bristles becoming weaker and shorter as they ascend; hind tibia without a regular series of bristles on anterodorsal surface ..... *Exorista* Meigen

Facial ridges bristled on almost their entire extent ..... *Frontina* Meigen

Facial ridges bristled on less than their lower third 39

39. Prosternum bare; forwardly directed frontal bristles present and the frons about equally wide in both sexes; posterior sublateral bristle lacking; hind tibia without a regular anterodorsal fringe of bristles ..... **Demoticus* Macquart

Prosternum setulose or haired; forwardly-directed orbitals present only in the female, the frons in that sex much wider than in the male; posterior sublateral bristle present; hind tibia with a regular fringe of bristles on anterodorsal surface, sometimes one of the bristles longer than the others .... *Sturmia* Robineau-Desvoidy

40. First posterior cell of wing closed before attaining margin, and with a very short petiole; eyes almost bare; abdomen with discal bristles on second and third visible tergites ..... *Quadra*, n. gen.

First posterior cell of wing open; abdomen without discal bristles on second and third visible tergites, the apical series anterior to the hind margin in *Arrhenomyza* and simulating discals, especially at centre 41

41. Frons almost uniformly protuberant above and in front; its height above eyes at ocelli about equal to the length of third antennal segment (Text-fig. 21); para-

facials with quite strong, long, black hairs; eyes densely haired; hind tibia with a fringe of exceptionally long bristles on the entire length of anterodorsal surface ..... *Arrhenomyza*, n. gen.

Frons hardly projecting above eyes posteriorly in profile 42

42. Stem vein of wing (Radius) with strong setulose hairs on posterior side of its basal section as in Rhiniinae (Fam. Calliphoridae); eyes long haired; parafacials haired to almost the lowest level of eyes; intermediate sternites of abdomen with long black apical spines ..... **Protohystricia*, n. gen.

Stem vein of wing without any setulose hairs on posterior side of its basal section 42*a*

42*a*. Eyes quite densely long haired (× 10); second segment of arista not longer than thick; parafacials quite copiously haired on their entire extent .... *Winthemia* Robineau-Desvoidy

Eyes microscopically haired or bare (× 34); other characters not as above in combination 43

43. Second segment of arista hardly as long as thick; parafacials sparsely setulose to below middle; eyes practically bare ..... *Anamastax* Brauer and Bergenstamm

Second segment of arista more than four times as long as thick; parafacials setulose to lowest level of eyes 44

44. At least the lower third of facial ridges with very short black setulae; parafacials with about the inner fourth (nearest the facial ridges) bare, the remainder with rather short hairs; eyes with microscopic hairs (× 34) .. *Tritaxys* Macquart

Not more than the lower fifth of the facial ridges with setulae; parafacials with some quite strong and moderately long bristles extending along a portion of the inner margin, which are well differentiated from the fine short hairs laterad of them ..... **Gonia* Meigen

Notes on some New Zealand Genera.

I have a number of New Zealand genera which were sent to me about ten years ago by Mr. Morris M. Watt, but I do not purpose dealing with all of them at this time, as it may be possible to find an opportunity to prepare a separate publication dealing with them at some future time. The new genus *Protohystricia* is unique, so far as I am aware, in possessing setulose hairs on the posterior side of the basal section of the stem vein of the wing on its upper surface, as in the calliphorid subfamily Rhiniini and in some Muscidae. The other genera dealt with are so similar to some which occur in other faunal regions that I suspect they may yet be found in Australia, and they are included in the key for comparative purposes.

Genus Protohystricia, nov.

Generic characters.—Eyes rather conspicuously haired, frons of male about half as wide as that of female, the orbits without strong backwardly-directed upper bristles in male, and with two strong forwardly-directed supraorbitals in female, outer verticals undeveloped in neither sex, ocellars of moderate length; parafacials haired; bristles descending a little below bases of antennae; face concave in profile, much as in *Winthemia*; third antennal segment about twice as long as second; arista almost bare, second segment not longer than thick; epistome projecting beyond anterior level of frons; palpi long; facial ridges setulose on lower fourth. Prosternum and centre of propleura bare; posterior sublateral bristle lacking, acrostichals and dorsocentrals strong; postalars two; pteropleural bristle strong; sternopleurals 3; scutellum with very strong bristles on apical half. Abdomen stout, with strong discals and apicals on all tergites except first, apices of at least the intermediate sternites with very strong bristles. First posterior cell open, fourth vein much curved beyond angle, base of third vein above and below

and the posterior upper side of basal section of stem vein setulose. Lower calypter bare, wide at apex, lying close against scutellum.

Genotype, *Hystricia pachyprocta* Nowicki.

PROTOHYSTRICIA PACHYPROCTA (Nowicki).

Specimens from Dunedin, 20.11.1916, Paradise, 1.1.1920, and Bold Peak, 24.12.1913 (Watt).

The genus *Hystricia* has the lower calypter haired above as in *Nemoraea* Meigen, and neither it nor any related form has the setulose hairs on the base of stem vein.

Genus CALCAGER Hutton.

This genus was originally erected for the reception of four New Zealand species, but in 1927 Curran published a statement that in his opinion there were three genera involved in Hutton's concept, designated *apertum* Hutton as the genotype, and removed *turbidum* Hutton to the new genus *Plagiomyia.*

Calcager, as now restricted, is very similar to *Cyrtophloeba* Rondani, a genus occurring in Europe, North and South America. It differs from the latter in having a series of long setulose hairs on the parafacials instead of long strong bristles, and in having the outer cross-vein of the wing nearer to the inner cross-vein than to the bend of fourth, instead of nearer to the bend.

I have seen *Calcager apertum* Hutton from Ruapehu, New Zealand, 7.1.1922 (Fenwick).

Genus CALCAGERIA Curran.

This genus was erected in 1927 for a new species from New Zealand, *incidens* Curran. It is closely similar to *Opsophagus* Aldrich, erected for the reception of two Peruvian species in 1926 (*Trans. Amer. Ent. Soc.*, 52, p. 15). I have a specimen of *incidens* before me, have compared it with the genotype of *Opsophagus*, and find that the only differences between the two lie in the arrangement of the frontal and parafacial bristles. In the American genus the strong parafacials connect with the outer, or supraorbital, forwardly-directed series, while in the New Zealand genus they connect with the inner marginal series. This difference may be of no significance, as there is generally some variation in the bristling in related forms. The only other feature worth noting is that the outer cross-vein is closer to the inner in the New Zealand than in the American species.

I would consider the genera synonymous. Both belong near *Voria* Robineau-Desvoidy. The known genera with retracted outer cross-vein of the wing have been dealt with by Aldrich in the paper referred to above.

Genus PEREMPTOR Hutton.

This genus was erected by Hutton for the reception of two New Zealand species. The description given is fairly good, but the genus is in no way related to *miltogramma* Meigen, with which it is compared, that genus belonging to the Metopiinae, a subfamily of Calliphoridae. It does bear a resemblance to *Procissio* Hutton, the only character given for its separation therefrom being the lack of discal bristles on the second and third visible tergites of the abdomen.

I have but one species before me, *vittata* Curran, described in 1927 in a paper already referred to herein.

PEREMPTOR VITTATA Curran.

This species is the only one with the abdomen reddish-yellow. The black dorsocentral vitta on abdomen is tapered slightly apically, the legs are yellow, apices of tarsi darkened. Head in profile as Text-figure 34.

Localities.—Ruapehu, Routeburn, Milford I., and Eglinton V. The initial in the last listed locality may mean Valley.

It should be noted that *Hystricia lupina* Swederus will run down very well to the present genus in my key, but the space between the vibrissae is three or more times as great as the width of the third antennal segment in that species, while in the present one it is less than the width of the third segment. I believe that it will be necessary to erect a new genus for the reception of *lupina*. It is remarkable in the possession of bicoloured strong bristles on the abdomen—black at bases and golden yellow at apices.

THE FOOD PLANTS OR HOSTS OF SOME FIJIAN INSECTS. III.

By William Greenwood, H.D.A.

[Read 28th August, 1929.]

Since Part ii of this paper appeared (These Proceedings, xlix, 1924, 161) a number of new records have been obtained and it is now thought desirable to publish them.

Mr. Veitch left Fiji in June, 1925, but the writer hopes to be able to continue this work.

As in previous parts practically all the insect identifications have been made by the Imperial Bureau of Entomology, and thanks are also due to the Royal Botanic Gardens, Kew, and to the Government Botanist, Queensland, for naming some of the plants.

Credit for the various records is made by initials as follows:

C.T. ..... C. Turbet	E.B. ..... E. Bryan, Jr.
W.F. ..... W. Froggatt	H.P. ..... H. Phillips
J.I. ..... J. Illingworth	R.V. ..... R. Veitch
H.S. ..... H. Simmonds	W.G. ..... W. Greenwood

The records credited to Mr. H. Phillips have been seen and verified by the writer. All records, except those credited to Phillips, Veitch and Greenwood, have been taken from various publications.

LEPIDOPTERA.

Except where otherwise stated, the records for Lepidoptera refer to the feeding habits of the larva.

Nymphalidae.

Melanitis leda F. Eats the leaves of *Panicum maximum* Jacq. (Gramineae). W.G.

Lycaenidae.

Thecla agra Hew. Feeds on flower buds and flowers of *Lantana Camara* L. (Verbenaceae). H.S.

Lampides baetica L. Feeds on flowers of *Crotalaria striata* DC. (Leguminosae). W.G.

Zizera labradus Godt. Feeds on flowers and young pods of *Phaseolus vulgaris* L. (Leguminosae). W.G.

Pieridae.

Belenois clarissa Butl. Eats the leaves of *Crataeva religiosa* Forst. (Capparidaceae). W.G.

Terias sulphurata Butl. Feeds on the leaves of the following Leguminosae: *Cassia Tora* L. and *Sesbania grandiflora* Pers. Both H.P.

Sphingidae.

Herse convolvuli L. Feeds on leaves of *Ipomoea tuberculata* Roem. et Schult. (Convolvulaceae). H.P.

Hippotion celerio L. Eats the leaves of the following Araceae: *Caladium bicolor* Vent. and *Calla aethiopica* L. Both W.G.

Arctiidae.

Utetheisa pulchella L. Attacks the leaves and green pods of *Crotalaria retusa* L. (Leguminosae). R.V.

Geometridae.

Colutoceras cheramota Meyr. Eats the leaves of *Tagetes patula* L. (Compositae). H.P.

Thalassodes pilaria Gn. Feeds on the leaves of *Anacardium occidentale* L. (Anacardiaceae). W.G.

Noctuidae.

Achaea janata L. Feeds on the leaves of the following Euphorbiaceae: *Codiaeum variegatum* Bl. and *Euphorbia pilulifera* L. Both W.G.

Othreis fullonica L. The imago feeds on ripe fruits of *Psidium Guayava* L. (Myrtaceae). H.P.

Heliothis obsoleta Fab. Feeds on leaves of *Lycopersicum esculentum* Mill. (Solanaceae). H.S.

H. assulta Guen. Larva eats through green fruits and feeds on seeds of *Cardiospermum halicacabum* L. (Sapindaceae). H.P.

Chasmina tibialis F. Eats the leaves of *Hibiscus tiliaceus* L. (Malvaceae). H.P.

Polydesma umbricola Boisd. Feeds on leaves of *Enterolobium Saman* Prain (Leguminosae). H.P.

Prodenia litura F. Eats the flowers of *Mimosa pudica* L. (Leguminosae). W.G.; also the leaves of *Brassica campestris* L. var. *chinensis* (Cruciferae). H.P.

Phytometra chalcites Esp. Feeds on the leaves and green fruits of *Lycopersicum esculentum* Mill. (Solanaceae). W.G.

Eublemma cochylioides Guen. Feeds on the flower heads of *Lactuca sativa* L. (Compositae). W.G.

Anomis vitiensis Butl. Eats the leaves of *Urena lobata* L. (Malvaceae). W.G.

A. flava F. Eats the leaves of *Sida retusa* L. (Malvaceae). W.G.

Earias fabia Stoll. Feeds on the green fruits of *Malvastrum tricuspidatum* A. Gray (Malvaceae). W.G.

Amyna octo Guen. Feeds on leaves of *Parasponia velutina* Planch. (Urticaceae). W.G.

Eriopus maillardi Guen. Feeds on the leaves of the following ferns: *Adiantum hispidulum* Sw. and *Lygodium reticulatum* Schk. Both H.P.

Pyralidae.

Pycnarmon cribrata F. Feeds inside folded over leaflets of *Vitex trifolia* L. (Verbenaceae). W.G.

Maruca testulalis Hb. Feeds on flowers of *Pongamia glabra* Vent. (Leguminosae). W.G.

Nacoleia diemenalis Guen. Eats the leaves of *Indigofera Anil* L. (Leguminosae). W.G.

Margaronia indica Saund. Feeds on the leaves of the following Cucurbitaceae: *Lagenaria vulgaris* Ser. and *Cucurbita Pepo* DC. Both H.P.; *Luffa aegyptiaca* Mill. W.G.

Terastia meticulosalis Guen. Larvae tunnel in the peduncle and eat the pedicel and flower buds of *Erythrina indica* Lam. (Leguminosae). W.G.

Piletocera signiferalis Wlgr. Larva feeds in dead branches of *Plumeria acutifolia* Poir. (Apocynaceae). W.G.

Marasmia venilialis Wlk. Feeds on leaves of *Alternanthera sessilis* R. Br. (Amarantaceae). H.P.

Pterophoridae.

Sphenarches caffer Zell. Feeds in buds and on the leaves of *Hibiscus rosa-sinensis* L. (Malvaceae). H.S.; and on the flowers of *Canavalia gladiata* DC. (Leguminosae). W.G.

Eucosmidae.

Polychrosis rhipidoma Meyr. Feeds on flowers of *Clerodendron amicorum* Seem. (Verbenaceae). W.G.

Argyroploce illepida Butl. Feeds on seeds inside pods of the following Leguminosae: *Mucuna aterrima* Holland. W.G.; and *Erythrina indica* Lam. H.P.

A. lasiandra Meyr. Feeds in the hypocotyl of the seedlings of *Bruguiera rheedii* Bl. (Rhizophoraceae). W.G.

Tortricidae.

Adoxophyes fasciculana Wlk. Feeds on leaves of *Rhamnus vitiensis* Benth. (Rhamnaceae). W.G.

Lyonetiadae.

Decadarchis heterogramma Meyr. Feeds in pith of dead stems of *Tithonia diversifolia* Hemsl. (Compositae). R.V.; and in old dry pods of *Mucuna aterrima* Holland (Leguminosae). W.G.

Gelechiidae.

Brachyacma epiochra Meyr. Feeds in ripe pods of *Cassia occidentalis* L. (Leguminosae). W.G.

Cosmopterygidae.

Limnoecia anthophaga Meyr. Larvae feed on decaying flowers. W.G.

Labdia calida Meyr. Feeds on the ripe seeds of the following Leguminosae: *Mucuna aterrima* Holland and *Crotalaria striata* DC. and in the woody part of the fruit of *Poinciana regia* Boj. (Leguminosae). All W.G.

L. rationalis Meyr. Feeds in seed heads of *Tithonia diversifolia* Hemsl. (Compositae). W.G.

Glyphipterygidae.

Glyphipteryx isoclista Meyr. Feeds on inflorescence of *Rhynchospora aurea* Vahl. (Cyperaceae). W.G.

Olethreutidae.

Spilonota holotephras Meyr. Eats the young leaves of *Metrosideros polymorpha* Gaud. (Myrtaceae). W.G.

Crocidosema plebeiana Zell. Larva feeds in seed heads of *Sida retusa* L. (Malvaceae). W.G. (The record of this insect feeding in fruits of *Eugenia malaccensis* L. in Part ii of this paper is incorrect.)

Galleriidae.

Corcyra cephalonica Stn. Feeds in seeds of *Gossypium barbadense* L. (Malvaceae) and *Oryza sativa* L. (Gramineae); also on linseed and chocolate. All H.S.

Heliodinidae.

Stathmopoda trichrysa Meyr. Probably rubbish feeder in bolls of *Gossypium barbadense* L. (Malvaceae). H.S. Also feeds in dead branches of *Plumeria acutifolia* Poir. (Apocynaceae). W.G.

Tineidae.

Hellula undalis F. Feeds on flowers of *Polanisia viscosa* DC. (Capparidaceae). W.G.

Plutella maculipennis Curt. Larva feeds on leaves of *Brassica juncea* Coss. var. (Cruciferae). W.G.

Gracilariadae.

Acrocercops sarcocrossa Meyr. Feeds on leaves of *Parinarium insularum* A. Gray (Chrysobalanae). W.G.

COLEOPTERA.

The records for Coleoptera refer to the feeding habits of the larva unless otherwise stated.

Rutelidae.

Adoretus versutus Har. Imago feeds on leaves of *Lagerstroemia indica* L. (Lythraceae) and *Alphitonia zizyphoides* A. Gray (Rhamnaceae). Both W.G.

Staphylinidae.

Philonthus discoideus Gray. Breeding in rotten seeds of *Vigna Catiang* Walp. (Leguminosae). W.G.

Erchomus atomus Kr. Breeding in rotten stalks of *Jatropha Curcas* L. (Euphorbiaceae). R.V.

Eleusis apicipennis Fairm. Breeding in rotten stalks of *Jatropha Curcas* L. (Euphorbiaceae). R.V.

Homalota pectinans Fauv. Breeding in rotten stalks of *Jatropha Curcas* L. (Euphorbiaceae). R.V.

Lespinus veitchi Brh. Breeding in rotten stalks of *Jatropha Curcas* L. (Euphorbiaceae). R.V.

L. impressicollis Mots. Breeding in rotten stalks of *Jatropha Curcas* L. (Euphorbiaceae). R.V.

Thamiaraea insigniventris Fauv. Breeds in the following rotten fruits: *Citrus medica* L. var. *limonum* (Rutaceae), *Citrus decumana* Murr. (Rutaceae) and *Spondias dulcis* Willd. (Anacardiaceae). All W.G.

Coenonica puncticollis Kr. Feeds in decaying stalks of *Saccharum officinarum* L. (Gramineae). W.G.

Dermestidae.

Anthrenus pimpinellae F. Larvae feed in woollen materials. W.G.

Bostrychidae.

Xylopsocus castanoptera Fairm. Feeds in dead stalks of *Tithonia diversifolia* Hemsl. (Compositae). R.V.

Rhizopertha dominica L. Larva feeds in seeds of *Phaseolus calcaratus* Roxb. (Leguminosae). W.G.

Ptinidae.

Anobium paniccum L. Larva feeds in herbarium specimens and in the seeds of the following: *Cicer arietinum* L. (Leguminosae), *Lycopersicum esculentum* Mill. (Solanaceae) and *Areca Catechu* L. (Palmaceae). All W.G.

Tenebrionidae.

Eutochia pulla Er. Larvae eat the seeds of *Zea Mays* L. (Gramineae) after planting. W.G.

Mordellidae.

Mordellistena dodoneae Montr. Larvae feed in dead stems of *Tithonia diversifolia* Hemsl. (Compositae). W.G.

Bruchidae.

Bruchus chinensis L. Feeds in seeds of *Cicer arietinum* L. (Leguminosae). W.G.

Anthribidae.

Araecerus fasciculatus de Geer. Larva feeds in dry fruits of *Duranta Plumieri* Jacq. (Verbenaceae). W.G.

HYMENOPTERA.

The records for Hymenoptera refer to the feeding habits of the larva.

Evaniidae.

Evania appendigaster L. Parasitic on the egg capsules of *Periplaneta australasiae* F. (Blattidae). R.V.

Scoliidae.

Scolia manilae Ashm. Feeds on the larva of the white grub, *Rhopaea vestita* Arrow. (Melolonthidae). R.V.

Ichneumonidae.

Echthromorpha diversor Morl. Parasitic on the larvae of *Polydesma umbricola* Boisd. (Noctuidae). R.V.

Agaonidae.

Blastophaga greenwoodi Grandi. Bred from fruits of *Ficus obliqua* Forst. (Urticaceae). W.G.

Proctotrupidae.

Telenomus nawaii Ashm. Parasitic on eggs of *Prodenia litura* F. (Noctuidae). H.S.

Encyrtidae.

Echthrogonatopus exitiosus Perk. Parasitic on larva of *Haplogonatopus vitiensis* Perk. (Dryinidae). W.G.

Saronotum australiae Perk. Parasitic on larva of *Haplogonatopus vitiensis* Perk. (Dryinidae). W.G.

Eulophidae.

Aspidiotiphagus citrinus Craw. Parasitic on *Aspidiotus simmondsi* Green and Laing (Coccidae). H.S.

Aneristus fumosipennis Gir. Parasitic on *Lecanium viride* Green (Coccidae). W.G.

A. ceroplastae How. Parasitic on *Ceroplastes rubens* Mask. (Coccidae). W.G.

Braconidae.

Apanteles platyedrae Wilkn. Parasitic on the larvae of *Platyedra gossypiella* Saund. (Gelechiidae) and *Decadarchis heterogramma* Meyr. (Lyonetiidae). Both H.S.

HEMIPTERA.

Practically all the records for the Hemiptera refer to the feeding habits of the nymph and imago, but in the Coccidae the male imago has aborted mouth parts and so cannot suck plant juices.

Pentatomidae.

Brachyplatys pacificus Dall. Feeds on stems of *Indigofera Anil* L. (Leguminosae). W.G.

Coleotichus sordidus Wlk. The adults feed on fruits of *Lantana Camara* L. (Verbenaceae). H.S.

Coreidae.

Melanacanthus margineguttatus Dist. Feeds on stems and inflorescence of *Crotalaria striata* DC. (Leguminosae). W.G.

Leptoglossus australis F. Feeds on leaves and stems of *Sechium edule* Sw. (Cucurbitaceae). W.G.

Mictis profana F. Feeds on leaves and stalks of *Albizzia Lebbek* Benth. (Leguminosae). W.G.

Lygaeidae.

Germalus pacificus Kirk. Feeds on stems of *Indigofera Anil* L. (Leguminosae). W.G.; and on fruits of *Lantana Camara* L. (Verbenaceae). H.S.

Tingidae.

Holophygdon melanesica Kirk. Feeds on leaves of *Rhaphidophora Merrillii* Engl. (Araceae). W.G.

Poekillopteridae.

Plestia marginata Montr. Feeds on leaves and stems of *Morinda citrifolia* L. (Rubiaceae). W.G.

Psyllidae.

Mesotomotoma camphorae Kuway. Feeds on *Thespesia populnea* Soland. (Malvaceae). E.B.

Aphidae.

Aphis gossypii Glover. Leaves and stems of *Vigna Catiang* Walp. (Leguminosae). R.V.; and leaves of *Impatiens Balsamina* L. (Balsaminaceae). W.G.

Aleurodidae.

Aleurodes comata Mask. On leaves of the following Gramineae: *Amphilophis glabra* Stapf and *Chrysopogon aciculatus* Trin. Both W.G.

Coccidae.

Aspidiotus simmondsi Green and Laing. On bases of leaves of *Cocos nucifera* L. (Palmae). H.S.

A. pangoensis Doane and Ferris. On bases of leaves of *Cocos nucifera* L. (Palmae). H.S.

A. destructor Sign. var. *transparens* Green. On *Eugenia malaccensis* L. (Myrtaceae). H.S.

Chrysomphalus dictyospermi Morg. Attacks *Cocos nucifera* L. (Palmae). H.S.

Icerya seychellarum Westw. Attacks *Citrus Aurantium* L. (Rutaceae). H.S.

I. purchasi Mask. On stems and leaves of *Mangifera indica* L. (Anacardiaceae). W.G.

Lecanium elongatum Sign. On leaves of *Aleurites triloba* Forst. (Euphorbiaceae). W.G.

Pseudococcus bromeliae Sign. Attacks *Ananas sativus* Schult. f. (Scitamineae). H.S.

P. longispinosus T.T. On inflorescence of *Calanthe veratrifolia* R. Br. (Orchidaceae). W.G.

Saissetia nigra Nietn. On leaves and stems of the following: *Sida retusa* L. (Malvaceae), *Malvastrum tricuspidatum* Gray (Malvaceae), *Coleus Blumei* Benth. (Labiatae), *Basella alba* L. (Chenopodiaceae), *Thunbergia erecta* Boj. (Acanthaceae), *Phyllanthus niruri* L. (Euphorbiaceae) and *Gaillardia pulchella* Foug. (Compositae). All W.G.

Vinsonia stellifera Westw. On leaves of *Calophyllum Inophyllum* L. (Guttiferae) and *Ficus Benjamina* L. (Urticaceae). Both W.G.

Pinaspis buxi Bouche. On leaves of *Cocos nucifera* L. (Palmae). H.S.

Lepidosaphes beckii Newm. Attacks *Citrus Aurantium* L. (Rutaceae). H.S.

THYSANOPTERA.

Microcephalothrips abdominalis Crawf. Feed in flowers of *Tridax procumbens* L. (Compositae). W.G.

Plesiothrips perplexus Beach. At base of leaves of *Saccharum officinarum* L. (Gramineae). W.G.

Chaelothrips idoliceps Karny. Feeding inside rolled over edge of leaf of *Ficus obliqua* Forst. (Urticaceae). W.G.

Taeniothrips longistylus Karny. Feeds in flowers of *Crotalaria striata* DC. (Leguminosae). W.G.

Haplothrips soror Schmutz. Feeds in flowers of *Tridax procumbens* L. (Compositae) and in the inflorescences of *Amphilophis glabra* Stapf (Gramineae) and *Pycreus polystachyus* Beauv. (Cyperaceae). All W.G.

ORTHOPTERA.

The records for the Orthoptera refer to the feeding habits of the nymph and the imago.

Blattidae.

Periplaneta americana L. (Omnivorous). R.V.

NEUROPTERA.

Agrionidae.

Ischnura aurora Brauer. Imago seen catching and eating the nymphs and adults of *Nesosteles sanguinescens* Kirk. (Tettigoniidae). W.G.

Chrysopidae.

Chrysopa sanvitoresi Nav. The larva feeds on nymphs of *Nesosteles sanguinescens* Kirk. (Tettigoniidae). W.G.

DIPTERA.

Stratiomyiidae.

Microchrysa maxima Bezzi. Bred from banana refuse. H.S.

Syrphidae.

Syrphus corollae Fabr. var. *vitiensis* Bezzi. Feeding on *Aphis gossypii* Glover (Aphidae). R.V.

Phoridae.

Dohrniphora cleghorni Bigot. Bred from onions imported from Australia. H.S.

Apiochaeta xanthina Speis. Bred from diseased pineapple suckers from Hawaii. H.S.

Micropezidae.

Telostylinus lineolatus Wied. Bred from bolls of *Gossypium barbadense* L. (Malvaceae). H.S. Larvae feed in ripe fruits of *Averrhoa Carambola* L. (Geraniaceae). W.G.

Ortalidae.

Rivellia connata Thoms. From diseased bolls of *Gossypium barbadense* L. (Malvaceae). H.S.

Lonchaeidae.

Lonchaea aurea Macq. Larvae feed in decaying branches of *Plumeria acutifolia* Poir. (Apocynaceae). W.G.

Trypetidae.

Dacus passiflorae Frogg. Larvae feed in fruits of *Carica Papaya* L. (Passifloraceae). H.S., in buds of *Passiflora quadrangularis* L. (Passifloraceae). H.S., in bolls of *Gossypium barbadense* L. (Malvaceae). H.S., and in the swollen peduncle of *Anacardium occidentale* L. (Anacardiaceae). W.G.

Ensina sororcula Wied. Larvae feed in flower heads of *Cosmos caudatus* H.B. & K. (Compositae). W.G.

Chloropidae.

Gampsocera decussata Bezzi var. *lissoxantha* Bezzi. From ripe cotton bolls. H.S.

Cadrema bilineata De Meij. From rotten cotton bolls. H.S.

Drosophilidae.

Mycodrosophila gratiosa De Meij. Larvae feed in the fungus *Lenzites repanda* Fr. W.G.

Drosophila ampelophila Loew. Larvae feed in fruits of *Psidium Guayava* L. (Myrtaceae). H.S.

D. ananassae De Meij. Larvae feed in decaying fruits of *Mangifera indica* L. (Anacardiaceae) and *Passiflora quadrangularis* L. (Passifloraceae). Both W.G.

D. bilimbata Bezzi. Larvae feed in decaying fruits of *Eugenia malaccensis* L. (Myrtaceae), *Citrus decumana* Murr. (Rutaceae) and *Spondias dulcis* Willd. (Anacardiaceae). All W.G.

Borboridae.

Leptocera puerula Rond. From stable manure. H.S.

L. ferruginata Stenh. From stable manure. H.S.

Milichiidae.

Milichiella lacteipennis Loew. From stable manure. R.V. From rotten seeds of *Vigna Catiang* Walp. (Leguminosae). W.G.

Desmometopa palpalis De Meij. From onions imported from Australia. H.S.

D. tarsalis Loew. From onions imported from Australia. H.S. From rotten seeds of *Vigna Catiang* Walp. (Leguminosae). W.G.

D. m-nigrum Zett. From rotten seeds of *Vigna Catiang* Walp. (Leguminosae). W.G.

Agromyzidae.

Melanagromyza alysicarpi Bezzi. Larvae mine in leaves of *Alysicarpus vaginalis* DC. (Leguminosae). W.G.

M. phaseoli Coq. Larvae mine in the leaves of the following Leguminosae: *Phaseolus calcaratus* Roxb. and *Vigna Catiang* Walp. Both W.G.

M. leguminum Bezzi. Larvae feed in pods of *Alysicarpus vaginalis* DC. (Leguminosae). W.G.

Liriomyza pusilla Meig. Mining in leaves of *Brassica juncea* Coss. var. (Cruciferae). W.G.

Dizygomyza bellidis Kalt. Larvae mine leaves of the following Compositae: *Erigeron bonariense* L. and *E. albidum* A. Gray. Both W.G.

Pseudonapomyza atra Meig. Larvae mine in leaves of the following Gramineae: *Saccharum officinarum* L., *Zea Mays* L. and *Sorghum halepense* Pers. All W.G.

Muscidae.

Atherigona excisa Thoms. From diseased or rotting cotton bolls. H.S.

A. excisa Thoms. var. *trilineata* Stein. Bred from rotting banana containing larvae of *Nacoleia octosema*. H.S. Bred from orange. J.I.

A. poecilopoda Bezzi. From rotting fruits of *Inocarpus edulis* Forst. (Leguminosae). H.S.

Fannia glabella Bezzi. Bred from rotting seeds of *Vigna Catiang* Walp. (Leguminosae). W.G.

Ophyra nigra Wied. From offal. H.S.

Musca domestica L. From onions imported from Australia. H.S.

Stomoxys calcitrans L. Bred from heaps of decaying grass cuttings. H.S.

Gastrophilus salutaris Clk. Larvae feed internally on mules. W.F.

G. intestinalis de Geer. Larvae feed internally on horses. C.T.

Calliphoridae.

Chrysomyia rufifacies Macq. From offal. H.S.

Microcalliphora varipes Macq. From offal. H.S.

Lucilia cuprina Wied. From offal. H.S.

Sarcophagidae.

Sarcophaga fuscicauda Bottch. From onions imported from Australia. H.S.

Tachinidae.

Actia striglinae Bezzi. Bred from larvae of *Striglina superior* Butl. (Thyrididae). R.V.

Simuliidae.

Simulium laciniatum Edw. The imago attacks human beings. W.G.

Mycetophilidae.

Plastosciara flavibasis Edw. Larvae feed in decaying stalks of *Saccharum officinarum* L. (Gramineae). W.G.

SIPHONAPTERA.

The Siphonaptera are blood sucking.

Pulicidae.

Ctenocephalus felis Bouche. On cattle and human beings. Both W.G.

FOURTH CONTRIBUTION TOWARDS A NEW CLASSIFICATION OF THE AUSTRALIAN ASILIDAE.

By G. H. Hardy, Walter and Eliza Hall Fellow in Economic Biology, Queensland University, Brisbane.

[Read 31st July, 1929.]

On some thoracic sclerites of the Asilidae.—Since the key to the tribes of the Asilidae was published (Hardy, 1927, p. 388), several important developments have taken place. At that time the old subfamily Laphriinae was amalgamated with the Dasypogoninae because the system upon which it was founded had collapsed, and its unsatisfactory status had been pointed out by many authors, from Schiner in 1866 to Melin in 1923. Subsequent to my contention that if the Laphriinae is to be retained, it would have to be done on a different scheme, Malloch (1928) proposed using the nature of the prothorax as an index of the subfamily. The excellence of this suggestion is indicated by the fact that it remains consistent with regard to six tribes. Laphriini, Atomosiini and another still left unnamed (see Hardy, 1928, p. 470) fall into Laphriinae under Malloch's interpretation, but it has yet to be shown that the combination stands as distinct from the remainder of the Dasypogoninae as do the Leptogasterinae and Asilinae, for there appears to be a much closer relationship between the proposed Laphriinae and the Dasypogoninae than is to be desired in two groups of subfamily status. If accepted, however, it opens the way to raising the Ommatiini to subfamily status, for that tribe bears a similar relationship to the remainder of the Asilinae.

For purposes of erecting tribes, characters of the thoracic sclerites doubtless will prove useful, but it is very evident that cases are to be found where any sclerite may be in some connection intermediate between one form and another which usually stands contrasted. The genus *Phellus* is an example, for here the membrane that surrounds the prosternum has apparently become chitinized, nevertheless leaving ridges that mark its nature.

In the Ommatiini, yet another form of an intermediate character is found; seen on dried specimens, it will be noted that there is a rather narrow neck of sclerite joining the two portions of the prothorax together, but a shallow depression between these two parts lends itself to the idea that the amalgamation has not taken place, and was so considered in my prior paper. On examining a specimen newly killed, it was found that the neck was continuous, so the two parts are now ascertained to be completely united.

Another character that seems to offer prospects of utility is the metasternum. This plate is separated from the anterior side of the hind coxae by a membrane, and usually is raised to lie in a plane at a considerable angle to adjacent parts of the pleura. In many Laphriini, it will be noted that a part of the pleura juts between the metasternum and the membrane at the base of the intermediate coxae, and in some cases is exceptionally wide, whereas in the Saropogonini, the

metasternum touches this membrane, and the parts of the pleura that intercept them on the Laphriini here terminate in an obtuse point. In the following account, that form found in the Laphriini is referred to as "metasternum separated from the intermediate coxae", whilst that of the Saropogonini is referred to as "metasternum adjacent to the intermediate coxae".

All the Australian forms have the metasternum adjacent to the intermediate coxae except the Leptogasterini, Laphriini and probably all the Asilini. Exotic forms regarded as belonging to the genus *Laphria*, those of a very hairy nature, apparently have these parts adjacent, but there is no unanimous opinion as to where the limits of the genus *Laphria* lie. Certain other forms have this dividing piece so narrow that at first it may appear missing. Whenever the character is given as "metasternum adjacent" in the following key, this is so conspicuously the case that dispute concerning the matter is hardly likely to arise.

Key to the tribes of the Asilidae.

1. Antennae provided with a long arista 2
   Antennae without an arista which, apparently, is reduced to a small spine or is obsolete. (DASYPOGONINAE) 4
2. Venation simple, the alula reduced. Pulvilli atrophied. Prosternum conspicuously combined with the pleural parts to form one plate; metasternum very narrowly separated from the intermediate coxae; metanotum bare.* (LEPTOGASTERINAE) ..... *Leptogasterini*
   Venation with R_{2-3} confluent with R_1, and M_3 confluent with M_4 at their apices; alula developed. Pulvilli developed. (ASILINAE) 3
3. Prosternum entirely isolated from other parts by a membrane; metasternum separated from the intermediate coxae; metanotum sometimes hairy. Arista bare ..... *Asilini*
   Prosternum not isolated from pleural parts of the prothorax, but rigidly held by a rather narrow confluent piece; metasternum adjacent to the intermediate coxae; metanotum bare. Arista feathered below ..... *Ommatiini*
4. Female genital armature furnished with a paired row of genital spines. Metasternum adjacent to the intermediate coxae; metanotum bare 5
   Female genital armature without such spines 6
5. Prosternum isolated by a membrane. Anterior tibiae often with a spur. Venation simple, or M_3 runs into M_4, or R_{2-3} runs into R_1, but the two sets of veins are not confluent on the same species ..... *Saropogonini*
   Prosternum completely fused with other parts of the prothorax. Anterior tibiae never with a spur. Venation simple. Antennae with four segments and a spine. ..... Tribe ————†
6. Prosternum isolated by a membrane, the membraneous area always being defined though sometimes chitinous; metasternum adjacent to the intermediate coxae; metanotum bare. Vein R_{2-3} never runs into R_1 7
   Prosternum fused with other parts of the prothorax. Vein R_{2-3} running into R_1, and M_3 into M_4. Anterior tibiae never with a spur. Antennae with only three segments and a spine 8
7. Vein M_3 runs into M_4. Anterior tibiae never with a spur ..... *Phellini*
   Vein M_3 never runs into M_4; anterior tibiae often with a spur .... *Brachyrrhopalini*

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* The nature of the metanotum, whether bare or otherwise, is not necessarily even of generic importance, but it is so often consistent on the Australian Asilidae that it is worth noting under characters of the tribe.

† Malloch compared an Australian species, unspecified under *Atomosia*, with the American genus *Laphystia*, but it is evident his specimen does not belong to the Atomosiini, and it may be a member of this unnamed tribe containing *Clinopogon* and *Cryptopogon*.

8. Antennae with a minute spine at the apex of the third segment. Metasternum separated from the intermediate coxae; metanotum bare ..... *Laphriini*
Antennae with a spine placed dorsally. Metasternum adjacent to the intermediate coxae; metanotum with hairs or bristles ..... *Atomosiini.* 9

Key to the genera of the Atomosiini.

9. Metanotum with numerous hairs; face with numerous hairs; rather large species. ..... *Cyanonedys*
Metanotum with only a few bristles; face with a few hairs; small species ..... *Atomosia*

Tribe **Ommatiini.**

There seems to be no suitable name for the type of arista having long hairs on one side only and I think the character "feathered" below—as given in the key—will meet the immediate needs of this hardly plumose type. The character of the prosternum has been described above, whilst the female genital armature was casually compared with that of the genus *Neoaratus* on a previous occasion. Recently this genital apparatus has come under a more detailed study, and it would seem that there are fundamental differences worth recording. The denser parts of the lamellae are four in all, the two upper ones are combined into one plate which is almost flat, scarcely arched, and the lower pair are similarly flattened and combined into one plate; surrounding these denser parts the plates are translucent. The character of the ventral plate is traceable in the lamellae of other Asilids, but the upper one I have not met with elsewhere in the superfamily. Below the lamellae is a large cavity, as in *Neoaratus*, and within it occurs the genital pore; the upper side of the cavity is membraneous, and near the pore occurs a somewhat translucent plate, with a pair of denser ridges along the lateral edges. The ridges are also found in *Neoaratus*, where also is the remnant of a chitinous median plate near the ventral lamella, which plate is entirely missing on *Ommatius*.

With regard to the lamellae on *Ommatius*, I have seen a similar arrangement in the Mecoptera, on the genus *Harpobittacus*. Here the anal papilla is shielded above by a plate that is emarginate at the apex, and below is a similar plate shielding the underside.

Tribe **Atomosiini.**

To the above key for tribes, I have added two good generic conceptions under Atomosiini, and there are only two permissible known to me, although more genera are recorded. An important discrepancy is found in *Atomosia*, for the typical form, *A. puella* Wied., has only six abdominal segments visible, whereas all the Australian species have the seventh quite conspicuous and fully formed, whilst the genitalia are more exserted; on this evidence *Atomosia* may ultimately be excluded from the Australian list.

Tribe **Laphriini.**

Hitherto Australian species of Laphriini have stood in literature under two generic conceptions, but the arrangement is utterly misleading. The Australian forms are here divided into two main groups on the presence or absence of strongly developed lateral spine-like bristles on most of the segments of the abdomen. Malloch proposed dividing American representatives of the genus *Laphria* on the presence or absence of metanotal hair, and Lundbeck had previously proposed

dividing European species also into two groups. In the latter system one group, containing the more robust, densely pilose forms with strong club-like hind femora, and mostly with a spine at the apex of the hind tibiae in the male, do not seem to have special individual bristles on the thoracic disc or scutellum; the other group, containing less robust forms with less strong legs, do not have the hind femora club-shaped, nor a spine at the apex of the hind tibiae, and always seem to have special bristles on the thoracic disc. Neither Malloch's nor Lundbeck's systems can be used to divide Australian material, all of which perhaps conforms best to the second group in each case.

Several undescribed species are before me and one of these, according to the following key, belongs to group 2, but the male genitalia would indicate its affinities are nearer group 1. The third group given below is not to be regarded as more than a colour combination group, and is not distinct from the second; nevertheless, I believe all its forms are intimately allied to each other.

Key to the species of Laphriini.

1. Each segment of the abdomen provided with one pair or more of lateral bristles; legs always slender and unicoloured. Group 1 2
   Abdomen without lateral bristles 4
2. Ovipositor always exserted, subcompressed, rather long and provided with lamellae almost as long as the rest of the ovipositor ..... *tectamus* Walker
   Ovipositor normal, rarely exserted when at rest, the lamellae being as long as wide 3
3. Wings suffused with brown, never with yellow ..... *clavatus* White
   Wings yellow, apical and posterior border being broadly black-brown ..... *ornatipennis* Macq.
4. Tibiae unicoloured. Group 2 5
   Tibiae bicoloured. Group 3. 9
5. All legs entirely blue-black; femora swollen ..... *queenslandi* Ricardo
   At least the posterior femora bicoloured 6
6. Thorax black; all femora bicoloured and swollen ..... *rufifemorata* Macquart
   Thorax metallic blue 7
7. Posterior femora very swollen 8
   Posterior femora normal ..... *flavifemorata* Macquart
8. Intermediate and posterior femora bicoloured ..... *comata* White
   Only the posterior femora bicoloured ..... *telecles* Walker
9. Abdomen fulvous at least in part; femora more or less swollen 10
   Abdomen entirely black; femora not swollen ..... *fulvipes* Ricardo
10. Abdomen mainly fulvous ..... *varians* White
    Abdomen fulvous only on the last one or two segments ..... *bancrofti* Ricardo

LAPHRIA TECTAMUS Walker.

Laphria tectamus Walker, 1849, 374; 1833, 559.—*Andrenosoma vidua* Bigot, 1878, 228.—*Nusa tectamus* Ricardo, 1913, 149.—*Andrenosoma tectamus* Malloch, 1928, 299.

This quite common species occurs in quantities on tree-trunks, during the latter half of the summer, and certain other forms recorded below are similarly found on trees. Bigot placed it in the genus *Andrenosoma*, whilst Ricardo, following Kertesz (1909), regarded that name as a synonym of *Nusa* under which species it has long stood. Malloch recently proposed reverting to *Andrenosoma*, but his arguments in favour of this were not founded upon a study of the Australian allies. I can find only one structure that will isolate the form, this consisting of the nature of the female ovipositor, and apart from that there are all kinds of grades and combinations that link the form intimately with the other Australian species

of *Laphria*. Even the colour and markings on the thorax that stand so boldly conspicuous, are linked by a similar pattern, less distinct, in *L. clavata*.

Characters of the species hitherto unpublished are: In the wing venation R_5 and M_1 vary greatly in the manner in which they run to the wing margin; they may be considerably separated, contiguous or confluent at their apex. The same may be said of certain other forms, including *L. rufifemorata*, so the character is not reliable for generic distinction. The abdomen has a rather long apical segment, about two-thirds the length of the preceding one, and the ovipositor is always exserted; in other species the ovipositor is normally partly retracted, the segment anterior to it being hidden or very narrowly showing. The lamellae are exceptionally long, nearly as long as the rest of the rather long subcompressed ovipositor; in other species the lamellae are little longer than wide.

The holotype is a female, and Ricardo described the male allotype, both being in the British Museum.

Laphria clavata White.

White, 1913, 237.

The holotype of this species is a female before me; the male allotype is also in my collection, but was overlooked by White when describing the form. The sexes agree in characters and conform to White's description, but a considerable amount of variation in the characters White selected renders that account a little untrustworthy. The markings of the thorax are similar to those on *L. tectamus*, but are not so bright. The veins R_5 and M_1 are not so wide apart as White would seem to indicate, but this character is not consistent enough to be of specific value.

Laphria ornatipennis Macquart.

Macquart, 1849, 73; Ricardo, 1913, 156.

This is evidently not uncommon as a species, but poorly represented in collections. It belongs to group 1 in so far as it agrees in venation, slender femora and abdominal bristles, and also, as far as can yet be ascertained, the external appearance of the male genitalia of all three is similar, whereas most of the following forms have the hypopygium appearing as if it were more specialized in structure. The holotype is a female in the Paris Museum, and Ricardo referred to a male, the allotype, in the British Museum.

Laphria rufifemorata Macquart.

Macquart, 1846, 73; Walker, 1855, 559; Ricardo, 1913, 154; White, 1916, 166.

Species allied to the present one form group 2, and are to be distinguished by the entire absence of abdominal bristles, and the completely metallic blue abdomen and tibiae. In all these the humeral angle is covered with a light tomentum, and usually a trace of the same is found along the transverse suture; the colour reaches its maximum on *L. queenslandi* where the humeral markings extend on to the thorax more widely than usual. The hind femora are almost invariably swollen and only on *L. flavifemorata* do they approach the slenderness of those in group 1. R_5 and M_1 may reach the wing border wide apart, close together or confluently. *L. rufifemorata* is to be distinguished by the yellow or orange basal half of all femora, and the black, scarcely blue-black, thorax.

The holotype female is in the Paris Museum, and Ricardo referred to males, one of which must be regarded as the allotype, in the British Museum.

LAPHRIA TELECLES Walker.

Walker, 1849, 376; 1855, 559; Ricardo, 1913, 154; White, 1916, 165.

From *L. rufifemorata*, this species is to be distinguished by the posterior femora being yellow only on the basal half, and the thorax is metallic blue. The holotype and allotype are in the British Museum.

LAPHRIA COMATA White.

White, 1917, 85.

Very near *L. telecles*, apparently having the same distribution. It may be a variety, as it is only distinguished by the intermediate as well as the posterior femora being yellow at the base. The holotype male is in the British Museum, the allotype female is in my own collection.

LAPHRIA FLAVIFEMORATA Macquart.

Macquart, 1849, 337; Ricardo, 1913, 157.

The leg coloration is variable, having a complete range such as is found in the three forms mentioned above, but is to be distinguished from them by the slender femora which conform to those species placed in group 1. The holotype female is in the Paris Museum, the male has not been seen.

LAPHRIA QUEENSLANDI Ricardo.

Nusa queenslandi Ricardo, 1918, 61.

In this species the veins R_5 and M_1 are confluent a little before the wing margin, which character appears very consistent in the present species and somewhat rare in the other species of the group. The completely blue legs, swollen hind femora and extensive white markings of the thorax readily distinguish the form. The holotype is a male in the British Museum, the female has not been seen in collections.

LAPHRIA NIVEIFACIES Macquart.

Macquart, 1849, 73; Ricardo, 1913, 158; White, 1916, 167; ? Hardy, 1918 (1917), 66.

This form is not before me at the present time, but I believe it belongs to group 2, and it may be an extreme colour variation of *L. flavifemorata*. A Sumatran species under genus *Maira* (see Kertesz, 1909, p. 203) seems to be regarded as conspecific on the authority of v.d. Wulp. The holotype, a female, "is apparently lost" (Ricardo).

LAPHRIA CALOPOGON Bigot.

Bigot, 1878, 226; Ricardo, 1913, 157.

Although this species is not definitely recognized, there can be little doubt that it belongs to group 3, which is distinguished by the abdomen being usually fulvous in part, and by both the femora and tibiae being bicoloured. The present species may be an extreme variation of the following form.

LAPHRIA VARIANS White.

White, 1917, 84.

The abdomen is mainly fulvous, but there is a certain amount of variation owing to a strong tendency for fuscous marks to occur; these may take the form

of a series of small spots, one on each segment, or may become wide so as to suffuse most of the area. The posterior femora are rather strongly swollen in this species, but slender on the others of the group known to me. The holotype male is in the British Museum, the allotype female and a paratype are in Mr. J. Mann's collection.

LAPHRIA HIRTA Ricardo.

Ricardo, 1913, 159.

This is said to have a blue-black abdomen that is fulvous at the sides, thus suggesting another extreme variation of *L. varians*, with which it seems to agree in structure. The holotype male is in the British Museum, and apparently is unique.

LAPHRIA BANCROFTI Ricardo.

Ricardo, 1913, 158.

The female is said to have the sixth and seventh segments of the abdomen wholly reddish-yellow, and only the sixth so coloured on the male. A male before me agrees in this character; the posterior femora are slightly swollen. The holotype and allotype are in the British Museum.

LAPHRIA FULVIPES Ricardo.

Ricardo, 1913, 158.

The abdomen is entirely dark on this form, no fulvous colour appearing; the posterior femora are slender as in group 1. The holotype female is in the British Museum, the male has not been seen.

LAPHRIA FULVICEPS Macquart.

Macquart, 1849, 376; Ricardo, 1913, 155.

This species is queried from Australia, and there is no specimen known to me that even approximately conforms to the description. "The type is apparently lost" (Ricardo).

Further tribes.

It does not seem practical, at present, to suggest lines along which the Asilinae may be divisible into further groups of more or less tribal value, but the Dasypogoninae is in need of three more tribes, two of which are to eliminate the genera *Stenopogon* and *Bathypogon* from the Saropogonini, under which they are standing on sufferance.

There is yet another genus, so aberrant that it will need to be put into a tribe of its own; the species does not conform to any genus known to me, the antennae are five-segmented, apically drawn out, arista-like, but terminate in the small spine of the Dasypogoninae, whilst the whole appearance is that of *Cerdistus*, with the long ovipositor depressed instead of compressed, and softer. White possibly had, of this genus, a male which he called *Saropogon dissimulans*, whilst my specimen is a unique female and possibly another species. I found the form at Sunnybank, Brisbane, during November, 1927, clinging to the underside of a twig, when I was searching for *Cerdistus*, many species of which rest on the top side of twigs, but I very much doubt if that habit is normal for the insect, as a diligent search over two seasons has yielded no more.

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SOME NEW SPECIES OF *STENETRIUM* FROM WESTERN AUSTRALIA.

By G. E. Nicholls, D.Sc.
(*Communicated by T. C. Roughley.*)

(Twenty-five Text-figures.)

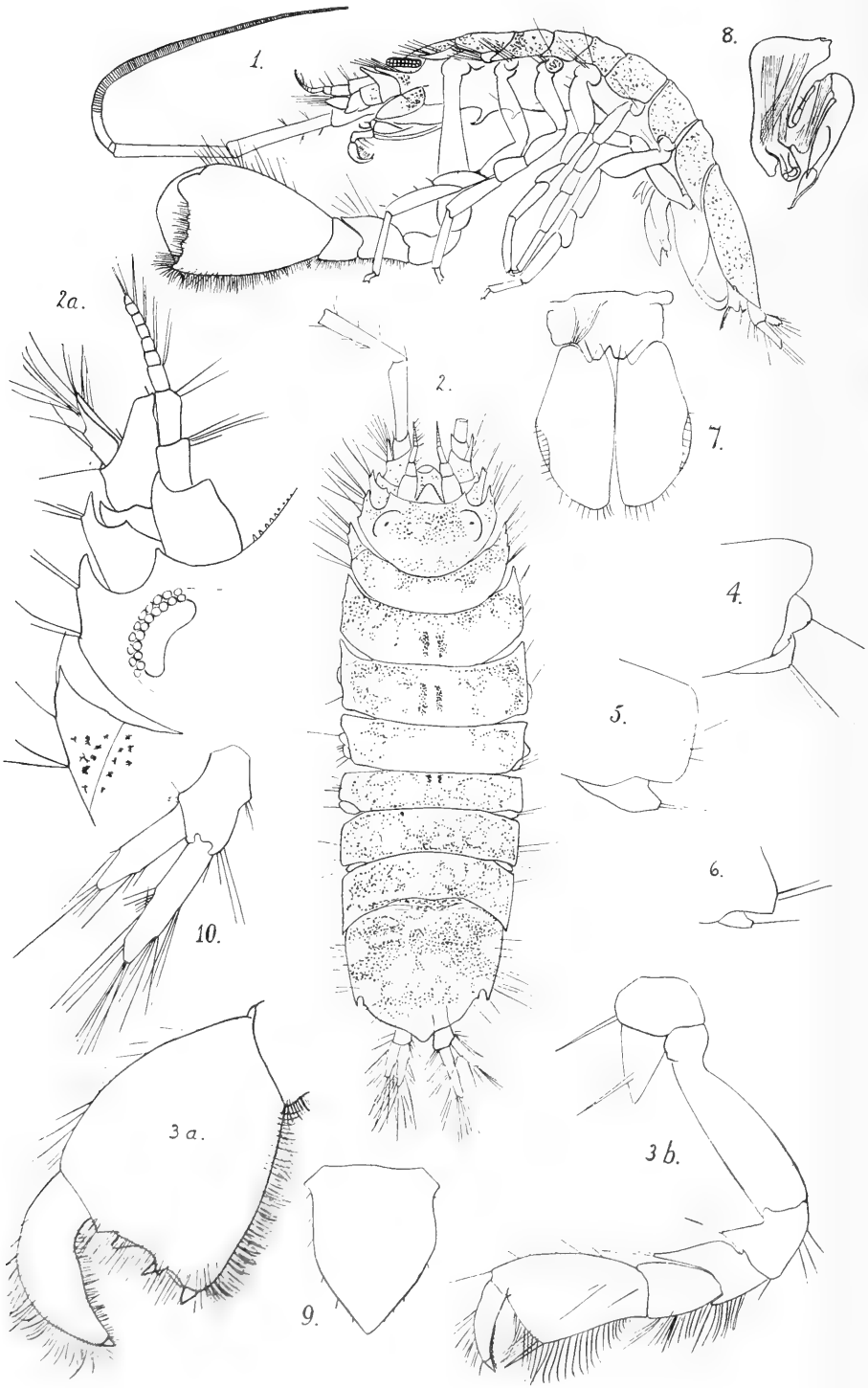
[Read 31st July, 1929.]

During the Autumn (1928) Short Vacation, a Field Instruction class was held at Dongarra. Amongst the material obtained during the course of field work were several specimens of a very fragile Isopod. These were found crawling upon seaweeds scraped from the piles of a disused pier some six feet or more below the surface of the water. Nearly a dozen specimens were taken, the largest measuring less than a quarter of an inch in length. They proved to be members of an undescribed species of *Stenetrium* (the first record of this genus from Western Australia), and were remarkable for the relatively immense hand of the male. The only previous record of the genus from Australian waters was that of Haswell (1881) who instituted the genus for two species, *S. armatum* and *S. inerme*, from the coast of New South Wales.

Doubt has since been thrown upon the correctness of the reference of the latter species to this genus, Hansen (1905) considering that it more nearly resembles in its structure an undescribed member of a genus belonging to the Janiridae, while Stebbing (1905) suggests that it belongs to the genus *Notasellus* Pfeller. If *S. inerme* is not correctly assigned to this genus, the Western Australian species from Dongarra described below is the second species belonging to this genus to be recorded from Australia. Since the publication of Haswell's original description of *S. armatum*, however, a number of species have been described from other parts of the world, the genus appearing to be practically cosmopolitan.

Learning that I had recently found and described a new Western Australian Stenetriid, Mr. Glauert very kindly permitted me to examine some specimens from Rottnest, obtained during the carrying out of a survey of the fauna of that Island. In the course of this work a number of littoral forms have been taken upon at least two occasions (Sept., 1927 and 1928) from the reef at Bathurst Point, near the north-east corner of the Island.

The material collected in 1927 proved to include no fewer than a dozen specimens of *Stenetrium*, eleven of which appeared at first sight to resemble my Dongarra form so closely that I was inclined to regard them as of subspecific rank only. A more careful examination, however, has revealed so many differences, warranting its recognition as a distinct species, and it is described below under the name of *S. spinirostrum*. In the same tube was a single specimen, sadly mutilated, but, nevertheless, very readily distinguished from both the two other Western Australian forms. A description of this, necessarily somewhat incomplete, is given under the name *S. truncatum*.


1.
8.
2a.
2.
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3a.
3b.
9.

All the material collected in 1927, was taken immediately after very heavy weather and, as no further examples of this species have since been secured, it is possible that it was a stray from deeper water washed on to the shore on some detached fragment of weed or reef.

The material taken in 1928 is still more abundant, including some twenty-three specimens in all; of these, nine are examples of *S. spinirostrum*, the remaining fourteen belonging to a species not previously taken and which I have named in compliment to Mr. Glauert. Apparently these two species live side by side, since they were both collected, not infrequently, from beneath the same stone just below tide mark. The smaller size, reduced condition of the eyes and remarkable development of the setae upon the much less developed gnathopods of the male, as well as its distinctive coloration, render it easily distinguishable from *S. spinirostrum*.

STENETRIUM MACROCHIRIUM, n. sp. Text-figures 1-10.

The head broader than long (3 : 2), with the anterior border on the whole concave, produced into a short rostrum, terminating in a bluntly-pointed apex not reaching to the anterior limit of epistome and armed on either side with minute spinules; produced laterally into a forwardly-directed flat spine-like process with lateral border twice notched or dentate; a broad triangular process midway between the rostrum and lateral process, forming the inner boundary of a deep incisure above the base of second antenna. The eyes long, curved and raised into a narrow ridge, practically forming the dorso-lateral border of head; with two rows of ten ocelli.

The *first antenna* is very short; its peduncle with a stout basal joint produced into a distal process on its lateral border; the second and third joints subequal; the flagellum short, in the female little more than half the length of peduncle and with seven joints, in the male longer and with fourteen joints.

The *second antenna* is approximately as long as the body; the basal joint of the peduncle produced into a curved process extending distally to the mid region of the third joint and notched near its apex, the second joint also produced; the flagellum longer than the peduncle with more than a hundred joints.

The *first peraeopods* (Gnathopods) differ markedly in the two sexes. In the male they are as long as the body; the coxa produced as the epimeral lobe projecting forwardly, marked off from tergum by a well defined ridge, the basos very stout, as long as or longer than the combined length of basos, ischios and meros of succeeding limbs; the ischios and meros expanded with the anterior border produced distally into pointed lobes; the carpos squarish, not produced; the propod, subquadrangular, considerably longer than the combined length of the three preceding joints (nearly as long as basos), longer than broad (6 : 5), both upper and lower margins very setose, the palm transverse, set with three stout conical spines; the dactyl stout, bent, slightly longer than the palm, larger than the basos of succeeding paraeopods, the upper margin strongly convex, both

Text-figures 1-10.—*Stenetrium macrochirium*, n. sp.
1.—Male, in side view. 2.—Female, in dorsal view. 2*a*.—Portion of head of same, more highly magnified. 3*a*.—"Hand" of male, in mesial view. 3*b*.—Gnathopod of female. 4.—Coxa of fourth peraeopod. 5.—Coxa of fifth peraeopod. 6.—Coxa of sixth peraeopod. 7.—First pleopod of male. 8.—Second pleopod of male. 9.—Second pleopods (operculum) of female. 10.—Uropod of female.

margins setose. In the female this appendage is much smaller and the hand less extravagantly developed; the palm slightly oblique, defined by a strong spine and set with numerous setae, the dactyl beset with short pectinate spines along the distal half of its palmar border.

The *pleo-telson* is somewhat broader than long, its lateral margin smooth, broken only by a single notch defined by a well-developed tooth-like spine; the posterior margin strongly convex and sinuate.

The *uropoda* in the male are considerably less than half as long as the pleotelson; in the female about half the length of the abdominal shield; in both, the endopod is slightly longer than the exopod.

Length.—Maximum 5·9 mm. (both male and ovigerous female).

Colour.—Generally of a pale grey, due to abundant scattered pigment on the yellowish-white background. Vestiges of a divided dark median stripe on segments 2, 3 and 5. In spirit, yellowish.

Occurrence.—Taken in April, 1928, crawling upon seaweed growing upon the piles of the pier at Dongarra, W.A. (lat. 29° S.); 3 males, 3 ovigerous females, 3 non-ovigerous females, 2 juvenile and 1 larva.

Detailed Description.

Apart from the greatly developed "hand" of the male, the sexual dimorphism is not very marked. The body is parallel-sided, the head and pleo-telson being slightly narrower than the peraeon. The maximum length was just less than 6 mm., one male and one female being presumably full grown and of equal size, the width barely exceeding 2 mm., and not being measurably wider even in the ovigerous female.

The uropods appear, in the two largest specimens, to be relatively longer in the female than the male, but with such scanty material one cannot be certain that this is a constant feature.

Upon the anterior border of the head (Text-fig. 2) there is a well-developed bluntly-pointed rostrum—the structure to which Hansen referred as the frontal plate. In *S. macrochirium* this arises almost from the level of the dorsal surface, so that there is practically no boundary line between dorsum and rostrum. The rostrum is free from pigment and its sides (but not its tip) are set with a number of minute spinules.

On either side the triangular process which overhangs the insertion of the first antenna and lies above and nearly mesially to the base of the second antenna seems, with the antero-lateral process, to frame the base of the second antenna. The eyes are large and form conspicuous curved black elongated ridges marking the dorso-lateral borders of the head; the lateral processes, though springing behind from the dorsal surface, slope downwards antero-laterally, to project forwardly well below the eyes. There is no trace of a suture dorsally between the head and the first thoracic segment. The distribution of the pigment suggests, however, the original distinctness of the two regions and it would appear that the lateral process might have been related primarily to the maxilliped segment; on the other hand it may quite well represent the post-mandibular process of *Asellus*, which is probably anterior to the segment of the maxilliped.

The *peraeon segments* (Text-figs. 1, 2) are subequal, the first and the fifth being actually shortest, the seventh, by a very little, the longest. In the ovigerous female the greatest width is attained by the third segment. In the first (Text-fig. 2*a*) and second peraeon segments the antero-lateral angles are produced into

short flattened plates, forwardly directed, the lateral border being notched or dentated, thus closely resembling the similar processes from the head and the basal joint of the second antenna and, like those, largely free from pigment.

It seems probable that these processes represent the coxopodites (or perhaps the precoxae) of peraeopods one and two, more or less fused with their respective segments. The process lies at a slightly different level from the rest of the lateral margin and, in the case of the first peraeon segment, the junction is marked by a well defined suture. In the only female dissected, the process came away with the gnathopod when that limb was removed (Text-fig. 3*b*).

Upon the tergum of the third segment these lobes are more slightly developed and the coxopodite projects a little beyond the lateral border, but upon the three succeeding segments the coxopodites may be seen, in dorsal view, as distinct rounded and freely projecting lobes. As in *Asellus* (Racovitza, 1920) and in *Phreatoicus*, these joints tend to shift progressively more posteriorly. In the third and fourth (Text-figs. 2, 4) the coxopodite occupies a position approximately half-way between anterior and posterior borders of its related segment. The fifth (Text-fig. 5) has come to lie at the posterior angle, and is exposed by an incisure of the postero-lateral margin. The sixth is definitely posterior (Text-figs. 2, 6) and appears in the gap between sixth and seventh tergites—while in the seventh segment the postero-lateral lobe projects sharply backwards in a flattened, acutely-pointed triangular process, which is devoid of pigment and which overlies the coxal portion of the related limb, only just visible in an incisure upon the posterior margin of the tergum.

Beddard has figured and described the occurrence of epimera in *S. haswelli*, differing somewhat from the condition found in my species. Miss Richardson, too, mentions the existence of these epimera in *S. stebbingi*, but, so far as I can discover, no other author makes any reference to these structures.

The pleo-telson has the characteristic shape of a broad short shield. An anterior pleon segment is marked off, but is not easily distinguished, appearing to be largely overhung by the hind border of the last peraeon segment.

The shield is broader than long (6 : 5) and shows a well developed latero-terminal notch behind which is a single minute serrulation; the shield then narrows rapidly to the median rounded and subtriangular terminal region.

Upon the dorsal surface generally are sparsely scattered long flexible setae; the telson bears a thin fringe of shorter setae, while from the anteriorly projecting lobes of first antenna, head and anterior peraeon segments arise a conspicuous set of stout spinose setae which project forwardly and upwards. These are represented on the more posterior segments by a few (two or three) long stiff setae which may arise from the margin of the tergal plate or from the coxopodite.

On the ventral surface there is a strongly-developed flattened hook-like median process arising from the sternum of first peraeon segment (Text-fig. 1) and projecting forwardly, and a smaller process upon the second. Upon the hinder two or three peraeon sternites are similar processes projecting backwardly. Barnard (1920) notes the existence of such "keels" in the South African species of *Stenetrium*, and I find similar structures in *Hyperoedesipus* and *Phreatoicoides*. In *Koonunga*, Sayce describes a similar condition.

Appendages.—The first antenna in the male stretches to a point about two-thirds of the length of the fifth joint of the peduncle of second antenna and has a length rather less than half of that peduncle. Its peduncle has the usual three joints, of which the first is much broader than those succeeding, having a width

equal to two-thirds of the combined length of second and third joint, and is considerably produced on its outer border. The second joint is but two-thirds the length and half the width of the first joint. The third peduncular joint is still less robust, its length not quite equal to that of the preceding joint. The flagellum is slender and short, subequal to the peduncle in length and usually with fourteen joints. In the female the appendage is smaller (Text-figs. 2, 2*a*), having a length barely two-thirds of the width of the head; the flagellum is relatively much shorter, equalling the length of distal two joints of peduncle only, and has fewer (6-7) joints.

The *second antennae* are peculiarly fragile. When not almost entirely lost they are generally mutilated, but they probably reach a length equal to that of the body. In a male 4·75 mm. long the incomplete antenna measured 4·2 mm.

As is so generally the case in the Asellota, the peduncle has six joints, of which the four proximal are quite short and stouter than the distal two. The second and fourth are particularly short. The first joint, as already noted, has developed on its outer border a conspicuous forwardly-directed spine-like process (Text-fig. 2*a*) strikingly like that arising from head and anterior peraeon segments. The third joint is very oblique, bearing upon its short external border the inrolled scale-like exopodite. Mesially it extends considerably, so that the fourth joint appears to arise almost laterally. The two succeeding joints are more slender, the sixth being slightly the longer, having a length equal to the proximal four joints combined. The flagellum, somewhat longer than the peduncle, is slender and tapering. From it setae arise at intervals in little tufts, as they normally do in many Crustacea from the end of the joints. But in this case segmentation has produced a large number of disc-like joints of gradually lessening dimensions and the setae are apparently borne on some only of these. In one specimen more than 120 of such joints were counted.

Mouth Parts.—Hansen gives a brief account of the structure of the mouth parts of *S. antillense*, while Stebbing describes those of *S. chiltoni* in some detail. Barnard also has described these appendages in *S. crassimanus* but for the most part little attention has been paid to them. In certain of the appendages the structure is remarkably constant, while in others there are considerable differences between the species.

The *labrum* calls for little comment. It is slightly broader than figured by Stebbing for *S. chiltoni* and much more densely setose apically.

The *right mandible* has a cutting edge with four stout teeth; at its base is a serrated knob which might represent the vestige of the accessory dentate edge. The teeth are spread out upon a flattened distal extremity which is most distinctly marked off from the more proximal region. From the median aspect of its base spring twelve stout curved and pectinate spines of the spine row. The stout molar process curves mesially, its flattened face being covered with stout tooth-like spines; its side is clothed distally by a number (more than twenty) of long curved pectinate setae.

The long three-jointed palp consists of a cylindroidal basal joint with two or three stiff setae distally; the second joint, nearly twice as long, arises from a narrowed base. It bears a short row of stiff setae and two other very long and stout, pinnate upon one side. These latter seem quite characteristic of *Stenetrium*. The third joint of the palp appears as a flattened lamina from the distal part of which a narrow lobe springs obliquely. The lamina is fringed with setae along one edge, the lobe appears to be setose on both margins.

The *left mandible* preserves both cutting edges of almost equal size with four and three teeth respectively. Near the base of the inner plate one very stout seta arises (as in *S. crassimanus*), this being pinnate on its ventral surface. As in the right mandible, the tooth-bearing portion is sharply marked off from the more proximal part of the limb, the rounded distal end of which bears a spine row of six setae, all of which are pinnate along the ventral face; molar and palp are much as on right mandible.

Labium: The median incisure is about as broad as deep, stiff curved setae forming a fringe along the distal two-thirds of the mesial margin. Terminally this margin is slightly excavated and then swells to a rounded apex, set with a curved comb-like set of stiff setae, otherwise the strongly convex outer borders are free from setae.

First maxilla: The rounded distal end of the inner lobe is set terminally with two stout short spines, somewhat spiky or knobbed, and surrounded by many fine setules. A little more proximally is one long curved seta.

The outer lobe is truncated; its end covered by ten (or perhaps more) stout serrated spines. On the mesial border distally are a few fine setules.

Second maxilla: Outer lobes equalling the inner lobe in length and set terminally with four stout pectinate setae with a few fine setules on the inner borders; inner lobe narrowing slightly towards the apex and set along its distal two-thirds with about seven stiffly curved setae, each pinnate along the distal border and with a stiff setule springing from the base. Terminally are four similar setae closely grouped. In the appendage of the opposite side, the distal clusters of setules on the mesial borders of the outer lobes appear wanting.

The *maxillipedes* seem closely to resemble those of other species figured. The third joint (first of the palp) is perhaps a little shorter than in *S. antillense* or *S. chiltoni*. The mesial edge of the inner plate terminates in two short adpressed spines and its transverse border is set with about seven curved setae (as in *S. chiltoni*). These, however, seem to arise from a broad base and there are no broad spine-like setae, like those described as occurring in *S. antillense* or *S. crassimanus*. Upon one side are six coupling hooks, four large and two slightly smaller; upon the opposite appendage there are but three larger hooks and only five in all. In the female I find only two large and two much smaller hooks separated by a distinct gap from which one hook has evidently been torn.

The epipod reaches practically to the level of the distal end of the inner lobe, narrows sharply, near its end, to a pointed extremity set with three or four evenly spaced setules.

The *gnathopoda*: In the male (Text-figs. 1, 3*a*) the tremendous development of this first pair of appendages gives the animal a most ungainly appearance, all of the joints sharing in the hypertrophy. The coxopodite is visible beneath the lateral margin of the tergal plate, but on removing the limb the separation occurred at the proximal end of the basos. In the female the coxopodite with epimeral extension came away with the limb, suggesting either the existence of a joint with some degree of mobility or a not very firm soldering of the limb to the segment in that region.

The large basos of the appendage in the male is flattened, appearing club-shaped, and is followed by elongated and enlarged ischios, meros and carpos, the two latter set with a ventral fringe of short stiff setae.

It is, however, in the distal two joints that the extraordinary development appears. The propodus is as long and almost as large as the pleo-telson; roughly triangular in shape with the base distal so as to afford a nearly straight palm.

Posteriorly (ventrally) the palm is limited by a very stout tooth-like spine, a second and very similar conical spine arising more proximally at a point about one-third of the length of the palm (Text-fig. 3*a*). A third stout spine with rounded end appears nearer to the dactyl, at the origin of which the palm arises into a triangular elevation. Externally the base of the dactyl is hidden by a very large triangular process of the propodus. The dactyl is very stout, nearly as long as the propodus, and strongly convex anteriorly but sharply bent upon its palmar edge. It shuts down upon the propodus upon its inner side and the tip of the dactyl does not visibly project. Both joints are very setose, the setae arising from the posterior margin of the propodus in small closely-set tufts are mingled with longer and more flexible setae arising from the internal surface of the joint and form a dense fringe along the border.

In the female the limb (Text-fig. 3*b*) differs from that of the male principally in its much smaller size. The coxa is produced into the long triangular lobe so conspicuous as the forwardly-projecting process of the first peraeon segment. The basos is stout and almost as long as the three succeeding joints; the ischios is expanded antero-distally into a broad compressed process; the meros shows a much more elongated process ending in a point bearing a stout seta. The carpos lacks this extension, its upper distal angle being subrectangular.

The propod is subquadrangular in shape, practically twice as long as deep, the upper border slightly convex, with few setae, lower border straight, densely fringed with setae; the palm slightly oblique with numerous setae forming a continuation of the ventral fringe, and quite obscuring a long spine which defines the palm. This fringe of setae extends along the ventral border of meros, carpos and propod, some being long and flexible, but mostly stiff and pectinate along one side.

At the base of the dactyl is a tuft of short flexible setae. The dactyl itself is short and curved, rather longer than the palm and with a stout terminal claw. Its convex upper border bears numerous tufts of short setules, the palmar surface set along its distal half with short stout spine-like setae, pectinate along one edge.

The *pleopods* have the arrangement and appearance described by Hansen as characteristic for the genus. In the male the members of the first pair (Text-fig. 7) are united by the fusion of the sympodite, from which springs a pair of irregular four sided plates. (Racovitza (1920) identifies these in *Asellus* as exopodites.)

In my species this plate is but sparsely setose terminally, a small portion of lateral margin being infolded. From the sympodite at the inner end of the base of the exopodite is a paired triangular process which may, perhaps, represent the vestige of a disappearing endopodite, a structure which seems elsewhere wholly to have vanished in the Asellota, although it is persistent and well developed in the Phreatoicidea. In several species of *Stenetrium* this process appears to be represented only by a stiff seta.

The second pleopod in the male (Text-fig. 8) differs but little from those figured by Hansen. It is relatively rather large, reaching an extreme length of nearly four-fifths of that of pleopod 1, the sympodite alone being more than half the length of that limb. The inner geniculate appendage has a rounder inner

curve, the second joint is somewhat narrow and ends in a sharp point slightly hooked terminally. The rounded exopodite has the appearance of a short scroll.

The third and succeeding appendages appear to be quite typical and are similar in both sexes, but in the female, as in all Asellota, only one of the two preceding appendages has been retained.

Racovitza, discussing this condition in *Asellus*, has pointed out that systematists generally have assumed, erroneously, that this persistent structure is the first pleopod and that it is the second which has been aborted. For the Asellidae he has been able to show that it is really the first which is lost and the second which persists. Although I have been unable, in my much smaller specimens, to distinguish the sternites of first and second pleon segments, I see no reason to doubt that the same conditions hold in *Stenetrium* as in *Asellus*, and that in the former genus, also, it is the first pleopod which is missing.

The appendage (Text-fig. 9), be it first or second, is the result, apparently, of the fusion, much more complete than in the case of the first pleopods of the male, of a pair of appendages to form a small operculum. Barnard records for South African species that this operculum has a bifid tip, a detail previously noted by Haswell (1881; 1885) for *S. armatum*.

In *S. macrochirium* it is shield-shaped with a broad base, widening slightly and then narrowing to curve out into a lateral convexity on either side, thence to taper away to a median-pointed apex without trace of division; the maximum width is but two-thirds of the length.

Uropods (Text-fig. 10): These are short, flattened structures having a length equal to, or more than, half that of the abdominal shield. They arise from the ventral surface near the middle line on either side of the rounded terminal projection. The peduncle is broad and widens distally to bear the flattened rami, the inner of which is slightly longer than the outer and is one and a half times the length of the peduncle. The margins of both rami are notched, long setae arising in the notches, and terminally there is on each ramus a tuft of very long setae, broken off short in many of my specimens.

STENETRIUM SPINIROSTRUM, n. sp. Text-figs. 23-25.

In general appearance very like *S. macrochirium*, from which it may readily be distinguished by the following characters:

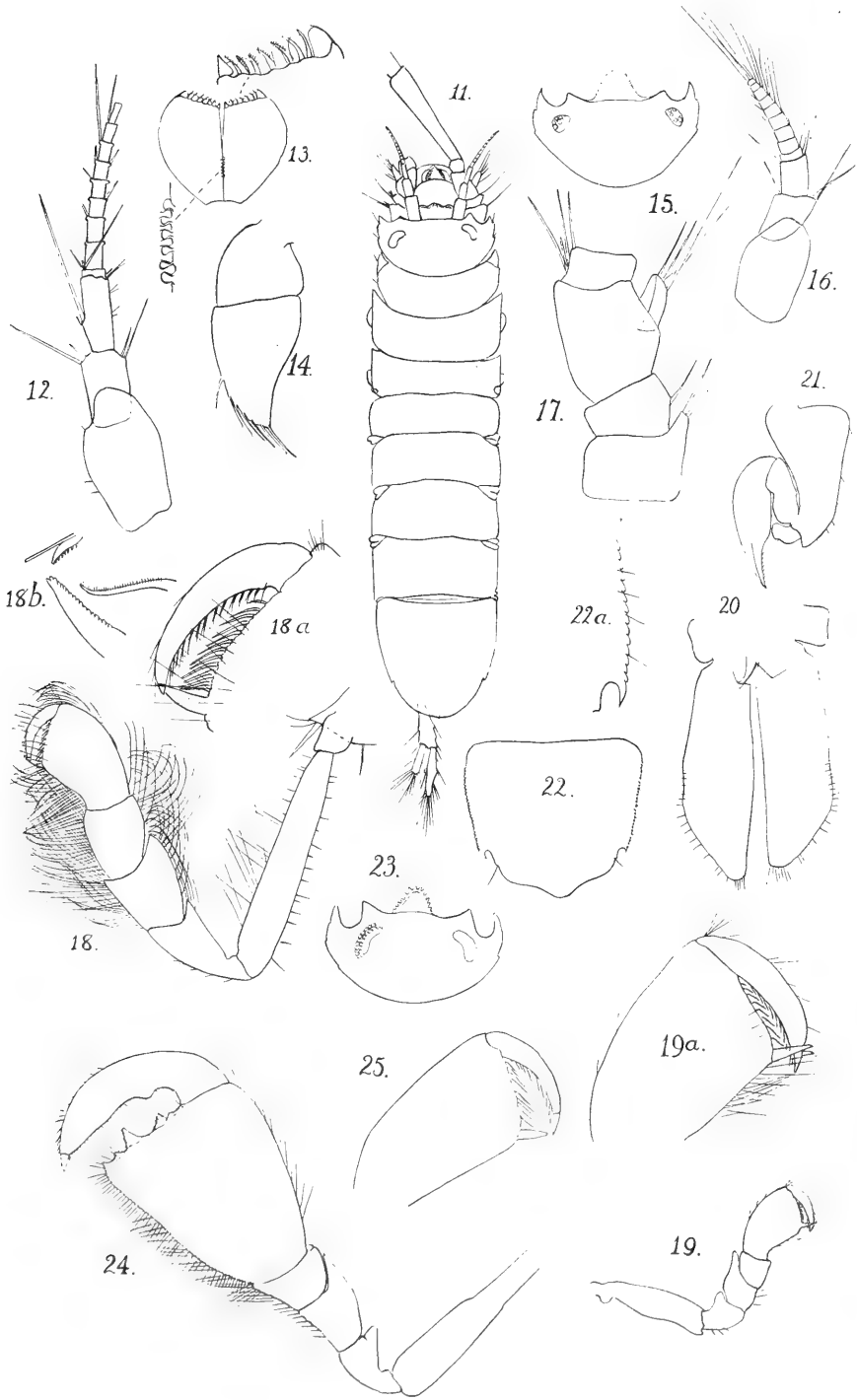
Head twice as broad as long, anterior margin sinuate, rostrum smaller, subtriangular and completely fringed with short spinules, anterior triangular processes less strongly developed.

Eyes with two rows of twelve ocelli.

First antenna relatively longer, peduncle without a strongly developed process on basal joint, second joint short, third nearly as long as first, first and second pigmented; flagellum with about seven joints in female and as many as seventeen in the male.

Second antenna not as long as the body, process upon first joint not extending much beyond second which is not produced; exopodite small in female, larger in male. Pigment developed upon first and third joints. Flagellum as long as peduncle (?) with about seventy joints.

First peraeopod: In the male, the basos is relatively shorter (as long as propod), the meros is much more definitely produced into a pointed process; the propod has upper and lower borders equal, almost straight and a little longer than the palm. The large spine, which in *S. macrochirium* bounds the palm, is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usually replaced by two low conical spines, although in some specimens upon one or other of the hands the single large spine is retained. The actual palm is relatively longer and the dactyl is longer still, the tip projecting well beyond the propod when the "hand" is closed. Upon its concave border, near its articulation, there is a prominent swelling. In the female there is little difference between the gnathopoda in the two species. On the palm there are nine or ten long and stiffly curved setae, pectinate upon the distal edge, while the inner (concave) border of the dactyl is furnished along its entire length with short and stout pectinate setae. Such spines and setae appear to be of very general occurrence upon palm and dactyl in the female Stenetriids.

The first *pleopods* in the male differ only in the number and position of the setae upon the exopodite. Upon the lateral border of the sympodite, also, there are three stiff setae not represented in *S. macrochirium*. The third pleopods have the endopodite considerably wider. The second pleopod of the female is considerably larger relatively and has many more short fringing setae.

Length.—The largest specimens (both male and ovigerous female) reach a length of 7 mm.

Colour.—Closely resembling *S. macrochirium*, the pigment spots are apparently fewer and larger. Upon segments two and three the group of spots which suggest a short paired dorsal line have actually coalesced with a definite double stripe.

Occurrence.—Collected by Mr. L. Glauert at Bathurst Pt., Rottnest Is., in September, 1927, and again a year later. In all twenty specimens were secured, these being taken under stones and on fragments broken from the reef.

STENETRIUM TRUNCATUM, n. sp. Text-figs. 11-14.

Body narrow, the length being four times the width, smooth and almost devoid of setae.

Head twice as wide as long, anterior border transverse, almost straight, rostrum broad and short, its length but two-fifths its width, the anterior margin marked by a row of pigment spots, the rest of the dorsal surface of the head being practically un-pigmented. Neither anterior nor antero-lateral processes of the head very strongly developed, lateral border bidentate.

Eyes reniform, with two curved rows of ocelli, about eighteen in all.

First antenna short, reaching nearly to the end of the first quarter of the fifth joint of peduncle of second antenna. Basal joint stout, with distal process, second and third joints subequal and progressively more slender and together as long as

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Text-figures 11-14.—*Stenetrium truncatum*, n. sp.
11.—Dorsal view. 12.—First antenna. 13.—Inner plates of maxilliped. 14.—Fifth pleopod.

Text-figures 15-22.—*Stenetrium glauerti*, n. sp.
15.—Dorsal view of head. 16.—First antenna. 17.—Base of peduncle of second antenna. 18.—Gnathopod of male. 18*a*.—Palm, more highly magnified. 18*b*.—Spine and setae from palm and dactyl. 19.—Gnathopod of female (same magnification as Fig. 18). 19*a*.—Hand of same, more highly magnified. 20.—First pleopod of male. 21.—Second pleopod of same. 22.—Pleo-telson of same. 22*a*.—Lateral border of same, more highly magnified.

Text-figures 23-25.—*Stenetrium spinirostrum*, n. sp.
23.—Head on dorsal view. 24.—Gnathopod of male. 25.—Gnathopod of female.

basal joint. Flagellum short, as long as combined length of first and second joints of peduncle, with nine or ten articles, apparently not quite complete.

Second antenna—only one preserved and this not complete. Probably not as long as body; neither first nor second joints of the peduncle produced, exopodite scale short; broken flagellum with 86 joints.

Maxilliped appears to agree quite well with Hansen's description of this limb in *S. antillense*, the inner lobe truncate and set with a single median spine-tooth and laterally a number of thin scale-like setae with one edge pinnate. A row of coupling hooks well developed and linking the two lobes so firmly that an attempt to separate the maxillipedes caused the united lobes to break away. In several of my specimens I have noted single hooks carried away from their attachment. These are apparently the structures described by Beddard as possibly of a sensory nature.

Peraeopods: All but one of the appendages of the peraeon are lost, being broken off at the distal end of the basos. The single limb has the usual characters, including the bi-unguiculate dactyl.

Pleopods: I am unable to determine the sex of my specimen, the first and second (or perhaps the second only) of the pleopods being lost. There are no signs of brood lamellae and from the many-jointed condition of the flagellum of the first antennae I expected to find the specimen a male. I failed, however, to make out the male appendages which in *S. macrochirium* are well developed and easily recognized.

The fifth pleopods are of interest, inasmuch as in them (alone, so far as I can discover in Stenetriids) the single lamella shows a division into two joints, as is usual for the exopodite in the third and fourth pleopods.

Pleo-telson slightly longer than broad, with the curved margin almost unbroken, the paired lateral incisure being very slightly developed; the margin generally smooth, marginal setae practically absent.

Uropod unusually long, three-fourths the length of the shield.

Length, 5·5 mm.; *width*, 1·3 mm.

Colour.—In spirit a creamy-white with very faint indication of pigment spots, sparsely scattered, probably scarcely visible in life, since Mr. Glauert informs me that some of the specimens were noted as being very light, almost white.

Occurrence.—Under stones below tide marks at Bathurst Pt., Rottnest Island, W.A., one specimen taken in September, 1927.

Remarks.—The species is readily distinguished from the other Western Australian forms by the shape of the rostrum, a feature which separates it also from *S. haswelli* Beddard, *S. stebbingi* Richardson, *S. fractum* Chilton, *S. antillense* Hansen, *S. chiltoni* Stebbing, *S. crassimanus* Barnard and *S. suldhana* Barnard.

A truncated rostrum such as that of *S. truncatum* is found, however, in the Eastern Australian species *S. armatum* Haswell, from which it differs in the shape of the pleo-telson.

The East Indian species, *S. siamense*, has a somewhat similar rostrum, but is altogether distinct from *S. truncatum* in the shape of its head which lacks antero-lateral and anterior processes and in its small rounded eye.

S. longicorne, from the Mediterranean, and the West Indian *S. antillense* are likewise described as having the rostrum transverse and wider than long. In each of these, however, the anterior rostral border is figured as concave and, in addition, there are differences in the basal joint of first antenna and in the condition of the pleo-telson.

Nobili has described very briefly and without figures two species of *Stenetrium* from the Touamotou Islands (Low Archipelago), both of which species have the rostrum transverse and truncated. From these it is less easy to distinguish *S. truncatum* owing to the imperfection of my specimen and the brevity of Nobili's description. There appear to be differences, however, in shape and proportion of head, length and number of joints of antenna, etc.

S. truncatum comes nearest, apparently, to some of the South African species described by Barnard.

From *S. dagama*, to which it bears considerable resemblance, it is distinguished by its proportions (length 5·5 mm., width 1·3 mm., or 4 : 1), shape of head, joints of antennulary flagellum and shape of pleo-telson; and, as already noted, it appears to differ from all described forms in the retention of the two-jointed condition of the exopodite of the fifth pleopod.

STENETRIUM GLAUERTI, n. sp. Text-figs. 15-22.

Head not quite twice as broad as long, anterior margin slightly sinuate, rostrum subconical with rounded apex, fringed with numerous minute spinules and with its upper surface also spinulose; anterior triangular processes not very strongly developed, antero-lateral process produced in usual manner.

Eyes nearly semicircular, with few (6-7) ocelli.

First antenna very short; basal joint stout with moderate distal process, second and third joints progressively shorter, their combined length barely equal to that of basal first joint. Flagellum in the male with nine joints not as long as basal joint.

Second antenna not as long as the body; the basal joint of peduncle produced into a slight process reaching to about middle of second joint; third joint stout, as long as two first joints combined; fifth and sixth joints subequal; flagellum longer than the peduncle.

First peraeopods (*gnathopod*) differ markedly in the two sexes. In the male with basos long and slender and bearing a number of long flexible setae upon its anterior border; ischios and meros with dorsal border produced distally into a pointed process; carpos not so produced; both upper and lower borders of these two joints set with long flexible setae, giving a very hairy appearance to the distal portion of the limb. Carpos relatively much larger than in other Western Australian species; propod not greatly enlarged and differing little except in size from that of the female (Text-figs. 18, 19). Its greatest length is almost twice its width, the somewhat oblique palm being defined by a stout spine, serrated along its palmar border. Dactyl curved, slightly longer than the palm, the palmar border of both propod and dactyl being set with pectinate spines similar to those described as occurring upon these joints in the female of *S. macrochirium* and *S. spinirostrum*. In the female the whole appendage is generally similar but much smaller.

The *first pleopods* in the male relatively much longer and narrower than in the other Western Australian species and, like those, showing the triangular lobes upon the sympodite which I have suggested may be the vestige of the endopodites.

The *second pleopods* show the sympodite of the usual form, but the exopodite is rather larger and curved mesially. The second joint of the exopodite is drawn out in a long point which is set barb-wise with proximally directed setae.

The opercular scale (fused second pleopods) in the female differs in no important respect from that of the other species above described.

Pleo-telson slightly broader than long, with well-defined lateral notch which is followed by a small serration bearing a stiff seta; the posterior margin is sinuate, with a rounded subtriangular terminal region.

The lateral margins are finely serrulate along their entire length and a few short setae occur. In this, as in the other species, a linear ring, such as that described by Stebbing for *S. chiltoni*, breaks away when dissecting out the pleopods. It is probably, as Stebbing suggests, a reduced anterior free pleon segment.

Uropod about half the length of pleo-telson.

The serrulate border of the pleo-telson distinguishes it not only from the other Australian species of this genus, but from all other Stenetriids with a conical or sub-triangular rostrum. *S. serratum* has but four or five serrations on either side and these are as large, almost, as that which bounds the latero-terminal notch. The small eye with very few ocelli, the extremely setose condition of the gnathopod in the male and, also, the barbed condition of the endopodite of the second pleopod in the male appear to be other features peculiar to this species.

Size.—Largest male, 5 mm.; ovigerous females slightly smaller.

Colour.—In spirit creamy-white, with two orange bands on fifth joint of second antenna, the more proximal of which occurs at the point where the flagellum of first antenna lies against it and this flagellum takes on the same colour. The sixth joint of second antenna also has two orange bands, this colour likewise marking the extremity of some of the limbs including the uropods.

Occurrence.—At Bathurst Pt., Rottnest Island, W.A.; 4 males, 6 ovigerous females, 1 non-ovigerous female and 3 juveniles taken by Mr. Glauert in September, 1928.

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NOTES ON GALL-MAKING COCCIDS, WITH DESCRIPTIONS OF NEW SPECIES.

By Walter W. Froggatt, F.L.S.

(Plates xii-xiii.)

[Read 28th August, 1929.]

Since my Descriptive Catalogue of the Scale Insects (Coccidae) of Australia was issued in 1921, I have collected a large number of new species of Coccids upon our native trees, and noted new host plants of others previously recorded. I have also had other specimens from correspondents in different parts of the Commonwealth, either new species, or examples extending the range of previously described species.

In these notes I deal with some of the gall-making species.

Apiomorpha macqueeni, n. sp. Plate xii.

I am indebted to Mr. John Macqueen of Mt. Emlyn, Millmerran, Queensland, for a fine series of this species formed upon the branchlets of the narrow-leaved Ironbark (*Eucalyptus pilligaensis*).

The ♂ gall unknown.

The ♀ gall very variable in form, as is shown in the accompanying plate (Plate xii), the outer bark-like surface sometimes forming a fringe of ragged filaments round the bare summit.

Female galls varying from dark reddish-brown to light brown in colour. Variable in form, general form fig-shaped; base broad, rounded, swelling out on the sides, contracted near the apex, which in immature forms is surrounded with a serrate edge; the summit smooth, slightly convex; the centre produced into a slender cone surrounding the minute circular apical orifice. Height 1½ inches. A cross-section shows a solid woody mass, with a very small spindle-shaped chamber through the centre. Immature galls stalked, spindle-shaped, sometimes rounded at the apex, at others truncate.

Female coccid resting head downward in the central chamber. General colour yellowish-brown, legs and antennae reddish-brown, tarsi and anal appendages black. Length 1 inch; width at base of cephalic segment, 2 lines. Cephalic portion rounded at apex, with thoracic, and first six abdominal segments turbinate; the last three abdominal segments forming a slender tube, tapering slightly to the extremity, which bears a pair of large blunt finger-like anal appendages. The cephalic portion lightly clothed with fine scattered hairs; abdominal segments with longer hairs. The characteristic bands of stout spines, found on the abdominal segments in most species of this genus, are wanting.

Apiomorpha fletcheri Fuller.

On the Lower Murray River near Euston, New South Wales, last October (1928) I found several large specimens of Red Box (*Eucalyptus bicolor*) so

thickly covered with the hard woody galls of this Coccid, that each branchlet was aborted into a gouty swelling or an oval mass. There were countless thousands of the female galls on each tree. Yet the male gall is unknown.

OPISTHOSCELIS CONVEXA, n. sp.

This species has a wide range. I have specimens from Mr. C. French, Jr., collected at Diamond Creek, Victoria, upon a Stringybark (*Eucalyptus macrorrhyncha*); others collected by Mr. L. Gallard at Gosford, N.S.W., on an undetermined species of *Eucalyptus*. I have taken it upon Ironbark (*Eucalyptus* sp.) in Why Why Forest, Macksville, and on a similar Ironbark at Warrah, New South Wales.

Male galls scattered over the surface of the leaves; small, reddish-brown, tubular structures with the apices fringed with serrate projections. Height 2 mm.

Female galls produced upon the base of the leaf stalks or along the slender branchlets. The basal portion brown; general form circular, broadest at the base, with apical portion forming a slightly convex, smooth, yellowish-brown lid. This lid is encircled by a scar or suture; the apical orifice, keyhole-shaped, in the centre of apical lid, is surrounded with a fine ring. Height 3½ mm.; breadth 4 mm.

Female coccid reddish-brown; cephalic portion darkest. Length 2 mm.; breadth, 3½ mm. General form, viewed from above, heart-shaped; the cephalic portion striated, forming a rounded pad fitting closely to the bottom of the gall-chamber; the rostrum aborted, situated between two rounded plates. The thoracic segments swelling out in folds on either side; the third thoracic segment bearing a pair of very long legs, folded on either side and turned over the dorsal surface; the femora stout, tibia and tarsi very long, slender, cylindrical, the latter terminating in a blunt tip. The abdominal segments rounded on the dorsal surface, segmental divisions well defined, each covered with blunt thorn-like spines which form transverse bars down the centre to the rounded apex, smaller spines scattered over the dorsal surface.

OPISTHOSCELIS GLOBOSA, n. sp. Plate xiii, fig. 2.

This species differs from *Opisthoscelis convexa* chiefly in the larger size and swollen form of the female gall. I have specimens from Mr. C. French, Jr., from Victoria, on an undetermined species of *Eucalyptus*, and others from Hornsby, N.S.W.

Male galls on surface of leaves, tubular, apex closed in immature specimens; in fully developed galls apex open but margin not serrate. Height 2 mm.

Female galls formed on the smaller branchlets, a broadly rounded or oval mass at junction with branchlet, 9 mm. at base. Height 5 mm. The apical portion similar in general form to that of the previous species, but the lid dark brown, flattened or depressed, with the surrounding scar much deeper, and the whole surface roughened.

Female coccid dark brown, similar in general form to *Opisthoscelis convexa* but broader, with the depression between the thoracic segments when viewed from above deeper. Length 3½ mm.; breadth 3 mm. The spines upon the abdominal segments form transverse bands much more irregular than in the previous species, with the rest of the surface of the segments studded with smaller shorter spines or tubercles. Derm showing no other distinctive pores.

OPISTHOSCELIS MASKELLI Froggatt. Plate xiii, figs. 1, 4.

The type species were described from specimens collected on the foliage and branchlets of the Large-leaved Ironbark (*Eucalyptus siderophloia*) growing about Flemington, near Sydney.

I have specimens from Mr. C. French, Jr., collected at Ashburton, Victoria, on *Eucalyptus melliodora*. The range of this species is extended to Southern Queensland. I have a very fine series in all stages of development upon the foliage and twigs of the Bimble Box, *Eucalyptus populifolia*, collected by Mr. I. Macqueen at Millmerran.

OPISTHOSCELIS RECURVA, n. sp. Plate xiii, fig. 3.

I collected these galls upon the foliage of an undetermined species of *Eucalyptus* on the hills at Warrah Station, near Willowtree, N.S.W.

Male galls of the usual tubular form, produced upon the surface of the leaves; tips slightly crenulated. Height 3 mm.

Female galls brown, the basal portion forming a circular platform upon the twig, divided from the base of the true gall by a contracted reddish scar, which is broadest at the base, rounded, and tapering to the apex which curves sharply downward like the beak of a parrot; tip truncate, with oval apical orifice. Diameter at base 9 mm.; height 9 mm.

Female coccid chocolate-brown, dorsal surface shining, flattened, broadly oval; the ventral surface convex, fitting closely into the bottom of the gall chamber; the tip of the abdomen forming a projecting lobe, turned up over the back; the long slender legs folded over the back, resting along the outer margins. When treated with potash, the cephalic portion is truncated in front, the sides of the thoracic segments very slightly rounded; the abdominal segments narrowing to the anal lobe. Antennae dark brown, stout, of uniform thickness to pointed tip, six-jointed. Beak chitinous, short, round at tip; first two pairs of legs wanting, no trace of them on derm; hind pair of legs abnormally developed, femora broad at base, tapering to apex; tibia and tarsus long, slender, tubular, the latter five times the length of the tibia, including the long tarsal joint rounded at the tip. The derm with four groups of dark brown, opaque, dermal cells round the antennae, first and second thoracic segments with two patches of similar cells on either side, third with a smaller patch near the base of the femora of the hind legs; the thoracic segmental division and first two abdominal segments marked off with a slender dark brown chitinous band; the whole of the derm covered with scattered groups of circular yellow pores varying in number from a dozen or more to three in each group. Length 5 mm.; breadth 4 mm.; length of hind leg 9 mm.

SPHAEROCOCCUS LEAI Fuller.

This beautiful little gall coccid was described by Fuller from specimens he collected near Perth, Western Australia, upon an undetermined species of *Casuarina*. A fine wood block is given of the galls in my Catalogue (Part iii, 1921, p. 11). In 1920 I found the galls plentiful at Trangie, N.S.W., upon the branchlets of the "Belah" (*Casuarina Cambagei*). Last year I found them upon the "Bull Oak" (*Casuarina Luehmanni*) growing on the red cliffs of the Murray River near Robinvale, Victoria.

MASKELLIA GLOBOSA Fuller.

Fuller (*Agric. Gazette N.S.W.*, 1897) defined the genus *Maskellia* as what he called a gall-making dicuspid coccid. This coccid has a very wide range and infests a number of different species of Eucalypt. It is not uncommon about Sydney and sometimes transforms the young foliage into a mass of tangled matted branchlets and aborted foliage a foot or more in diameter. The male galls are little red horns or spines upon the surface of the leaves, the female coccids turning the branchlets into cylindrical, or oval swellings each with a little nipple above the hidden coccid. Finally, as the coccids mature, this becomes a dead branch. In a box swamp on the Murray River, near Robinvale, Victoria, I observed two large Red Box trees (*Eucalyptus bicolor*) with the tips of every drooping branchlet aborted into small masses of these characteristic galls, which gave the trees a remarkable appearance.

EXPLANATION OF PLATES XII-XIII.

Plate xii.

Apiomorpha macqueeni, n. sp.

Showing foliage of *Eucalyptus pilligaensis* and the different forms of the galls formed by *Apiomorpha macqueeni*. The short broad form in the right hand corner is the adult female gall.

Plate xiii.

Fig. 1.—*Opisthoscelis maskelli*, showing all forms of development of the galls on twigs and foliage.
Fig. 2.—*Opisthoscelis globosa*, n. sp. Male and female galls.
Fig. 3.—*Opisthoscelis recurva*, n. sp. Male and female galls.
Fig. 4.—*Opisthoscelis maskelli*. Adult galls.

REVISION OF AUSTRALIAN GEOMETRIDAE (LEPIDOPTERA).

CONTAINING A REVISION OF THE ARCHAIC TYPES OF THE FAMILY, WITH NOTES AND DESCRIPTIONS OF NEW SPECIES.

By Gilbert M. Goldfinch.

(Plates xiv-xvi and four Text-figures.)

[Read 25th September, 1929.]

For some time I have had in my collection a number of species of the archaic types of this family, which I was unable satisfactorily to identify, but recently, through the kindness of other Lepidopterists and some of the Museums in Australia, I have had in my charge for examination almost the whole of the species hitherto recorded from Australia.

I have therefore ventured to prepare the present paper, which is intended to be a revision of the Australian species which fall under Groups 1 and 2 in Mr. L. B. Prout's Monograph of the family (Genera Insectorum, fasc. 129, 1912). This attempt will, I hope, help to unravel some of the difficulties which have confronted Australian Lepidopterists working in the group.

In those cases in which I have ventured to differ from Dr. A. J. Turner and Mr. Prout, I must ask indulgence, for I have been fortunate in having available for study long series of some species which perhaps were not accessible to those workers.

In the generic descriptions I have adopted the notation used by Dr. R. J. Tillyard in his "Insects of Australia and New Zealand".

My thanks are specially due to the following: The Director of the South Australian Museum for the opportunity afforded me to examine the Lower and Lucas types contained in the Museum collection; Dr. A. J. Turner for the loan of specimens and for many valuable suggestions; Mr. George Lyell for the loan of types and other specimens; Mr. W. B. Barnard for the opportunity to examine the valuable specimens collected by him at Cape York and Toowoomba, and for the gift of many specimens; Dr. G. A. Waterhouse for the gift of many specimens; the Director of the Australian Museum and the New South Wales Government Entomologist for their ready permission to consult their libraries.

Key to Genera.

1. **Vein R_2** arising separately from cell 2
   Vein R_2 not arising separately from cell 5
2. **Thorax** and abdomen not crested ..... *Protophyta*
   Thorax crested and abdomen often so 3
3. **Thorax** with small posterior crest, ♂ antennae simple ..... *Rhuma*
   Thorax strongly crested, ♂ antennae bipectinated 4
4. **Rs** and **M_1** of hindwings not stalked, thoracic crest exaggerated, posterior tibiae without terminal process ..... *Heliomystis*
   Rs and **M_1** of hindwings usually stalked, thoracic crest moderate, posterior tibiae of ♂ with stout terminal process ..... *Sterictopsis*

5. Posterior tibiae with terminal spurs only* ..... *Crypsiphona*
Posterior tibiae with median and terminal spurs* 6
6. Antennae in ♂ not bipectinate 7
Antennae in ♂ bipectinate 8
7. ♂ antennae simple (minutely ciliated) ..... *Epipristis*
♂ antennae dentate with tufts of short cilia ..... *Aeolochroma*
8. Hindwing with projecting teeth on veins M_3-Cu_{1a}-Cu_{1b} and 2A 9
Hindwing without projecting teeth on veins M_3-Cu_{1a}-Cu_{1b} and 2A 10
9. Head with hood of scales projecting above face, antennal pectinations in ♂ long ..... *Cyneoterpna*
Head without hood of scales above face, antennal pectinations in ♂ very short ..... *Paraterpna*
10. Hindwings and sometimes base of forewings with tufts of scales ..... *Pingasa*
Fore and hind wings without tufts of scales 11
11. Robust build with broad and spreading tegulae ..... *Hypobapta*
Slender build with tegulae normal 12
12. Hindwings with Sc + R_1 closely approximated to cell to well beyond middle ..... *Oenochlora*
Hindwings with Sc + R_1 diverging from cell before middle 13
13. Hindwings with Rs and M_1 stalked ..... *Austroterpna*
Hindwings with Rs and M_1 separate ..... *Terpna*

* Except *Hypobapta eugramma* in which the median spurs are absent.

1. Genus Protophyta.

Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 648; Prout, *Gen. Insectorum*, fasc. 129, 1912, 22.

Face smooth. Tongue well developed. Palpi moderate, obliquely ascending, second joint rough-haired above and beneath, terminal joint moderate. Antennae in ♂ bipectinate, apices simple, in ♀ minutely ciliated. Thorax not crested, densely hairy beneath. Abdomen not crested. Posterior tibiae not dilated, all spurs present. Hindwings without costal expansion at base, frenulum and retinaculum in ♂ well developed, in ♀ frenulum represented by a tuft of hairs. Forewings with termen crenulate; R_1 from cell approximated to or anastomosing with Sc at a point, R_2 from cell approximated to or anastomosing with stalk of R_3-R_4 beyond R_5, R_{3-4} and R_5 stalked from before apex of cell; M_1 separate, from apex; M_2 and M_3 separate; M_2 remote from M_1 but above middle of discocellulars, Cu_{1a} separate. Discocellulars curved inwards.

Hindwings with termen dentate; Sc + R_1 closely approximated to cell to well beyond middle, Rs and M_1 separate, M_2 remote from M_1, M_3 and Cu_{1a} separate, discocellulars curved inwards.

Type, *P. castanea* Lower.

1. Protophyta castanea. Pl. xiv, figs. 7, 8, 9, 10.

Pseudoterpna castanea, Lower, Proc. Linn. Soc. N.S.W., 23, 1898, 45.—*Protophyta castanea*, Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 648; Prout, *Gen. Insectorum*, fasc. 129, 1912, 22.

N.S. Wales: Port Macquarie (April), Toronto (April), Liverpool (January), Mittagong (February).

2. Genus Heliomystis.

Meyrick, Proc. Linn. Soc. N.S.W., (2) 2, 1888, 900; Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 647; Prout, *Gen. Insectorum*, fasc. 129, 1912, 22.

Face shortly hairy. Tongue well developed. Palpi moderate, porrect, basal and second joints densely hairy beneath, second joint hairy on upper surface,

terminal joint moderate. Antennae in ♂ pectinated nearly to apex. Thorax with a dense and spreading posterior crest; beneath densely hairy. Abdomen with strong median dorsal crests. Posterior tibiae dilated in ♂, with all spurs present (no posterior process present), an internal groove and tuft. Hindwings without basal costal expansion; frenulum and retinaculum in ♂ strong. Forewings: R_1 from cell anastomosing with Sc; R_2 separate from cell; R_{3-4} and R_5 stalked from apex of cell, M_1 connate; M_3 and Cu_{1a} separate. Hindwings: Sc + R_1 closely approximated to cell to beyond middle, Rs and M_1 separate, M_2 remote from M_1, M_3 and Cu_{1a} separate; discocellulars angled on M_2, dorsal strongly angled towards base beneath M_2, then rather strongly oblique.

Type, *H. electrica* Meyrick.

2. Heliomystis electrica. Pl. xiv, fig. 11.

Meyrick, Proc. Linn. Soc. N.S.W., (2) 2, 1888, 900; Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 648; Prout, *Gen. Insectorum*, fasc. 129, 1912, 23.

Q'land: National Park (low level); N. S. Wales: Wentworth Falls (May), Mittagong (November), Jervis Bay, Kosciusko (5,000 feet, January); Victoria: Gisborne (December); Tasmania: St. Marys.

3. Genus Rhuma.

Walker, *List Lep. Ins. Brit. Museum*, 21, 1860, 483; Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 646; Prout, *Gen. Insectorum*, fasc. 129, 1912, 23.

Face smooth. Tongue well developed. Palpi moderate, porrect or obliquely ascending; basal joint with long spreading hairs; second joint smooth; terminal joint short in both sexes. Antennae in ♂ slightly serrate, ciliated; in ♀ simple. Thorax with a small posterior crest; beneath densely hairy. Abdomen with strong median dorsal crests. Posterior tibiae with all spurs present; in ♂ strongly dilated, with internal groove and tuft, middle spurs long, terminal spurs abbreviated, a short stout terminal process. Hindwings without basal costal expansion; frenulum and retinaculum in ♂ well developed; frenulum in ♀ represented by a tuft of long hairs. Forewings: R_1 and R_2 arising separately from cell and free, R_{3-4-5} stalked, M_1 separate, M_3 and Cu_{1a} separate. Hindwings: Sc + R_1 closely approximated to cell to well beyond middle, Rs and M_1 separate, M_3 and Cu_{1a} widely separate; discocellulars not angled, moderately oblique, dorsal curved.

Type, *R. subaurata* Walker.

3. Rhuma subaurata.

Walker, *List. Lep. Ins. Brit. Mus.*, 21, 1860, 484; Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 647; Prout, *Gen. Insect.*, fasc. 129, 1912, 23.

Q'land: Yeppoon (Oct., Turner), Brisbane (Nov. and March, Illidge); N. S. Wales: Taree (Parkes).

4. Genus Sterictopsis.

Warren, *Novit. Zool.*, 5, 1898, 257; Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 645; Prout, *Gen. Insectorum*, fasc. 129, 1912, 23; Turner, *Trans. Roy. Soc. S. Aust.*, 46, 1922, 282.

Face smooth or moderately so. Palpi moderate, second joint rather long haired beneath, rough-haired above, third joint short in both sexes. Antennae in ♂ bipectinated, apices simple, in ♀ simple, minutely ciliated. Thorax with short

but dense posterior crest, beneath densely hairy, abdomen with 3 or 4 large dense median dorsal crests. Posterior tibiae with all spurs present, in ♂ dilated, with internal groove and tuft, and long posterior process. Hindwing without basal costal expansion, frenulum and retinaculum in ♂ well developed. Forewings: Termen rather straight; R_1 from cell and free (rarely anastomosing at a point with Sc), R_2 from cell and free, R_{3-4-5} stalked from apex of cell, M_1 connate, M_2 remote, M_3 and Cu_{1a} separate. Hindwings: Sc + R_1 closely approximated to cell to about middle, Rs and M_1 short stalked or connate, M_2 from near angle of cell, M_3 and Cu_{1a} well separated at base. Discocellulars moderately bent inwards.

Type, *Sterictopsis argyraspis* Lower (*inconsequens* Warren is a synonym).

Hitherto the principal distinction between *Heliomystis* and *Sterictopsis* was based on the separation of Rs and M_1 of the hindwings in the former, and their being stalked in the latter. In a species described below, this point proves unreliable, but I believe the two genera may well be separated by the great difference in the character of the thoracic crest, and the complete absence in *Heliomystis* of the terminal processes on the posterior tibiae.

4. Sterictopsis argyraspis. Pl. xv, fig. 5, 6.

Pseudoterpna argyraspis, Lower, *Trans. Roy. Soc. S. Aust.*, 17, 1893, 157.—*Sterictopsis inconsequens*, Warren, *Nov. Zool.*, 5, 1898, 257.—*S. paratorna*, Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 645.

Considerable confusion has existed in connection with this species, and Dr. Turner's remarks on *paratorna* in the above paper must be considered as referring to *argyraspis* Low. and not to the true *paratorna* Meyrick, which species was not known to him at that time.

Q'land: Duaringa (Oct.), Toowoomba (Sept. and Oct., Barnard), Brisbane; N. S. Wales: Sydney (Sept.), Blue Mts. (Jan., Waterhouse), Jervis Bay (Moss Robinson); Victoria: Gisborne (Nov. and Dec., Lyell); S. Aust.

I have examined the type of *argyraspis* Lower. It is, with little doubt, the same species as *inconsequens* Warren, and the name must therefore take precedence. The species is variable, and subject to considerable melanism as pointed out by Dr. Turner.

5. Sterictopsis divergens, n. sp. Pl. xv, fig. 4.

♂. 44 mm. Head snow white, with a few fuscous scales at vertex, lower portion of face and a line between antennae fuscous. Palpi fuscous, towards base white beneath, apex of second joint white ringed, apex of terminal joint white. Thorax with a short posterior crest, white, with three obscure fuscous bifurcate marks. Abdomen white, irrorated with fuscous scales, with three fuscous, white-tipped crests. Anal tuft grey. Legs black, ringed with white, except tibiae of posterior pair which are white. Forewings triangular, costa almost straight, apex rounded, termen moderately bowed, white, irrorated with black scales, yellowish suffusions, markings black. A longitudinal short black mark at base of costa, a series of black marks along costa, first small, before one-fourth, second larger at one-fourth, third at one-half, fourth at three-fourths, and fifth double before apex. First line arising from second costal spot, sharply angulated outwards in disc and again more deeply below cubitus, to dorsum at one-third. Second line from fourth costal spot, obliquely outwards to a point, thence downwards three times angled, thence four times angled to dorsum at two-thirds; an obscure subterminal waved whitish line from below apex to before tornus interrupted in middle by a

yellowish bar proceeding from a yellowish suffusion in discal area reaching the termen; an obscure waved fuscous terminal line. The area between first and second lines more or less suffused with yellowish. An obscure greyish oval discal spot ringed with fuscous, cilia fuscous, indistinctly barred with whitish. Hindwings evenly rounded, greyish-white, the terminal area broadly suffused with fuscous. An obscure grey blotch at end of cell. A waved black line from costa before apex not reaching the dorsum, acutely angled on M_3; an obscure greyish-white, waved subterminal line. Cilia fuscous, indistinctly barred with whitish. Underside yellowish-white. Discal spots large, black; large black subterminal blotches more or less obscure towards the margins.

Mittagong, N.S.W., 4 ♂ in November. Taken at light in Eucalyptus forest. Type in collection Goldfinch.

Of the four specimens known, two have veins Rs and M_1 of the hindwings short stalked, whilst the other two specimens have these veins connate. In no specimen are these veins actually separate as in *Heliomystis*, but the distinction between veins which are connate, and those which are separate though closely approximated, is slender, and would, in the case of *Sterictopsis divergens*, almost certainly be found to break down.

5. Genus Hypobapta.

Prout, *Gen. Insectorum*, fasc. 129, 1912, 41.

Face and vertex rough scaled, palpi rather short, second joint densely rough scaled, terminal joint short. Tongue present. Antennae two-thirds as long as costa, pectinated, towards apex simple, in ♀ serrate. Posterior tibiae not dilated, median spurs very short, or absent (*eugramma*). Thorax very robust, with or without slight posterior crest, tegulae very broad and extending almost to posterior edge of thorax, densely hairy beneath. Abdomen sometimes slightly crested. Hindwings without costal expansion at base, frenulum and retinaculum in ♂ well developed, in ♀ represented by a tuft of long hairs. Forewings: R_1 from cell from well before angle, R_2 from the common stalk of R_{3-4-5} from before R_5, M_1 approximated, connate or stalked, M_2 remote from M_1, M_3 and Cu_{1a} separate, discocellulars curved inwards below middle. Hindwings: Sc + R_1 approximated to cell to about middle, then diverging rather rapidly, Rs and M_1 separate, or connate (*eugramma*), M_2 remote, M_3 and Cu_{1a} separate, discocellulars curved inwards below middle.

Type, *H. percomptaria* Guenée.

The species here included differ in the presence or absence of median spurs in the hind tibiae, but, apart from this character, they exhibit real relationship and until the early stages are known it would appear more convenient to include *eugramma* with *percomptaria* and *barnardi*.

Key to Species.

1. Median spurs of posterior tibiae absent ..... *eugramma*
   Median spurs of posterior tibiae present 2
2. Postmedian line twice angled ..... *barnardi*
   Postmedian line almost straight ..... *percomptaria*

6. Hypobapta percomptaria.

Hypochroma percomptaria, Guenée, *Spec. Gen. Lep.*, 9, 1858, 280, Pl. 6, fig. 4.—*Terpna percomptaria*, Herr.-Schaff., *Samml. Aussereur. Schmett.*, i, 1858, 62 and 84, t. 95, fig. 544, 545.—*Pseudoterpna percomptaria*, Swinhoe, *Lep. Het. Oxf. Mus.*, 2,

1900, 385.—*T. percomptaria*, Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 638.—*Terpna* (*Hypobapta*) *percomptaria*, Prout, *Gen. Insect.*, fasc. 129, 1912, 41.—*Terpna percomptaria*, Turner, *Trans. Roy. Soc. S. Aust.*, 46, 1922, 281.

N. Q'land: Mt. Molloy (Dec.); Q'land: Clermont, Toowoomba, Brisbane; N. S. Wales: Newcastle, Sydney (June, Sept., Oct.), Blue Mts. (Dec., March), Mittagong (Nov., Jan.), Jervis Bay; Victoria: Melbourne, Gisborne (Jan., Feb., Mar., Apl., Dec.).

There is a ♂ specimen in the Australian Museum collection from Western Australia labelled as being this species. It is really *H. eugramma* Lower which closely resembles the present species. If this is the specimen referred to by Meyrick from Albany, the record under *percomptaria* may be disregarded.

7. Hypobapta eugramma. Pl. xv, fig. 16.

Hypochroma eugramma, Lower, *Trans. Roy. Soc. S. Aust.*, 15, 1892, 14; Prout, *Gen. Insect.*, fasc. 129, 1912, 248.

I have examined the type, together with a second specimen in the Lower collection, and a ♂ forwarded by Mr. Barnard from Toowoomba. Mr. Barnard's specimen is in excellent condition, and agrees well with Lower's description, excepting that the subterminal area is greyish fuscous, with only a small brownish area above the tornus. Lower did not perceive the absence of the median spurs in the posterior tibiae, but, apart from this, his description is accurate. The thorax and abdomen are not crested, and the face is slightly less rounded than *percomptaria*. There is a damaged ♀ in the South Australian Museum collection (46 mm.) from Castlemaine, Victoria. The ♂ in the Australian Museum from Western Australia, has the subterminal areas brownish, as described by Lower.

Q'land: Toowoomba (Sept., Barnard); Victoria: Castlemaine; South Aust.: (Parkside), Adelaide (Feb., Lower); W. Aust.

8. Hypobapta barnardi, n. sp. Pl. xv, fig. 15.

♂, ♀. 32 mm. Face whitish-grey, with a fuscous narrow transverse bar above middle, lower edge blackish. Palpi whitish, irrorated with black scales; terminal joint black. Thorax rather dark grey, tegulae with a broad black transverse posterior bar. Abdomen whitish, irrorated with brownish fuscous scales, forming transverse marks on the segments, tuft greyish-white. Legs: anterior and median pairs grey, tibiae fuscous, ringed with whitish; posterior pair whitish, irrorated with fuscous scales, the median spurs extremely small. Forewings triangular, costa almost straight, termen bowed; whitish-grey irrorated with fuscous scales, lines black; a transverse black mark from costa not reaching dorsum, closely followed by a similar mark almost reaching dorsum; first line outwards curved from costa at about one-fourth, to dorsum at middle; second line from costa at about two-thirds to dorsum at three-fourths, three times inwards curved, forming posteriorly projecting teeth, the first between veins M_2 and M_3, the second on vein Cu_{1b}, a linear black transverse discal mark, a dentate obscure whitish subterminal line from costa before apex to tornus, the subapical dentations bordered posteriorly by fuscous, and connected by fuscous bars with the terminal line which is slender and black. The first line is followed by a brownish fuscous narrow shade below the cell; cilia greyish-white, indistinctly barred with fuscous at the vein endings. Hindwings: Basal marks and first line absent, second line from costa before apex, to dorsum at about three-fourths, followed by a broad fuscous suffusion, paler towards the termen, enclosing an obscure whitish sub-

terminal line not reaching the costa. Discal mark, terminal line and cilia as in forewings. Beneath white, irrorated sparsely with fuscous scales, first line absent, discal marks and second lines as in forewings, followed in both wings by a fuscous suffusion not reaching the termen or tornus. Subterminal line indicated below the costa by three white dentations.

Q'land: Toowoomba (Oct., Barnard)—Holotype ♂ in collection Barnard; N. S. Wales: Hornsby (Tillyard); South Aust.: Murray Bridge.

9. Hypobapta xenomorpha.

Pseudoterpna xenomorpha, Lower, Proc. Linn. Soc. N.S.W., 40, 1915, 474.

I have examined the type, but in its present condition (almost descaled) it is difficult to form a sound opinion. It certainly belongs to this genus, and Lower's description appears to be accurate. The species closely resembles *H. eugramma* Lower, of which it might be considered the ♀, excepting for the presence of median spurs on the posterior tibiae and the different form of the first line which arises on the costa at one-fourth, thence straight to dorsum at one-half. There is also no transverse black bar on the tegulae as in *eugramma*. The specimen has been attacked by *Anthrenum*.

Fresh material will be necessary to decide the validity of this species.

10. ? Hypobapta diffundens.

Hypochroma diffundens, Lucas, Proc. Linn. Soc. N.S.W., 6, 1891, 298.

The type is not in the Lucas Collection in the South Australian Museum, but from the description it seems likely that the species is close to *H. barnardi* described in this paper. The first line appears to be differently formed, as is also the second line, whilst in the hindwing the basal streak and first line are entirely absent in *H. barnardi*.

Dawson River (1 ♂, Barnard).

This species must also await the capture of fresh material to ascertain its correct position.

6. Genus Austroterpna, n. g.

Face smooth, tongue well developed. Palpi rather long, porrected, clothed with long hairs above and beneath, terminal joint short, hairy. Antennae in ♂ bipectinated, towards apex simple. Thorax with a broad though rather short posterior crest, beneath densely hairy. Abdomen smooth, terminal segments with slight lateral tufts. Posterior tibiae with all spurs present. Hindwings without basal costal expansion, frenulum and retinaculum in ♂ well developed. Forewings with R_1 from cell anastomosing with Sc and R_2, $R_{2-3-4-5}$ stalked from apex of cell, M_1 short stalked with their common stalk, M_2 remote, M_3 and Cu_{1a} separate. Hindwing, Sc + R_1 approximated to cell to about one-third, thence rather rapidly diverging, Rs and M_1 stalked from angle, M_2 remote, M_3 and Cu_{1a} separate.

Type *A. idiographa*, n. sp.

Allied to *Terpna*, but distinguished by the anastomosis of vein R_1 with Sc and R_2, the stalking of veins Rs and M_1 of the hindwing, and by the absence of abdominal crests.

A. paratorna Meyrick has hitherto been confused with species of the genus *Sterictopsis*, but I doubt if they are really even closely related.

11. Austroterpna idiographa, n. sp. Pl. xvi, fig. 19.

♂. 32 mm. Head brown irrorated with grey scales. Palpi 2½, reddish-brown, towards base pinkish. Antennae brown, bipectinate, pectinations 1½. Legs: anterior and median pairs reddish-brown, irrorated with black, tarsi black, ringed at joints with paler, posterior pair pale reddish, irrorated with black. Thorax brownish grey, beneath clothed with long white hairs, pinkish tipped anteriorly. Abdomen brownish. Forewings triangular, costa evenly bowed, termen slightly waved, brown, densely strigulated with fuscous, towards the termen irrorated with white scales. Markings black, well defined. A small black spot at base enclosing a few red scales. First line from costa at one-fifth to dorsum at one-third, almost straight, edged on both sides with red scales. A slender linear transverse discal spot, followed by a whitish suffusion not reaching the costa, and bounded posteriorly by the second line. Second line from costa at beyond three-fourths, to dorsum at two-thirds, sinuate to a point on vein Cu_{1b}, which it follows to a point below middle of cell, thence sinuate to dorsum at two-thirds. A series of black triangular dashes from costa before apex to second line above middle, those near costa confluent. A dentate whitish subterminal line from apex to tornus. A fine black terminal line from apex to tornus. Cilia pinkish-brown, obscurely barred with fuscous. Hindwings whitish fuscous. An obscure transverse discal fuscous spot, first line absent, second line indicated on dorsum, a broad fuscous subterminal suffusion fading to pinkish-brown along termen. Terminal line and cilia as in forewings. Beneath whitish, irrorated with fuscous, and slightly pinkish tinged beneath costa in both wings, discal spots, second lines, and subterminal blotches as above, but less well defined.

N. S. Wales: (Narara) Gosford (April, Moss Robinson), 1 ♂.

Type in collection Goldfinch.

12. Austroterpna paratorna.

Hypochroma paratorna, Meyrick, Proc. Linn. Soc. N.S.W., (2) 2, 1888, 906.

1 ♂, Parachilna, Flinders Range, South Australia (Hale), in the South Australian Museum.

The specimen is in rather poor condition, but agrees structurally with Meyrick's species, and the markings appear to be the same. The wings are narrower and more elongate than in *A. idiographa*.

7. Genus Pingasa.

Moore, *Lep. Ceylon*, 3, 1887, 419.—*Pingasa*, Moore, *Lep. Atkinson Coll.*, 1888, 247.—*Skorpisthes*, Lucas, *Proc. Roy. Soc. Q'land*, 15, 1900, 143.—*Terpna* (part), Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 634.—*Pingasa*, Prout, *Gen. Insect.*, fasc. 129, 1912, 30; Turner, *Trans. Roy. Soc. S. Aust.*, 46, 1922, 280.

Face smooth (except in *paroptila*, which has dense projecting hairs). Palpi in ♂ moderate, in ♀ rather long, second joint densely rough-scaled, terminal joint in ♂ moderate, in ♀ rather long. Tongue well developed. Antennae rather long, in ♂ bipectinate to about two-thirds, in ♀ simple. Thorax not crested, beneath densely hairy. Abdomen with rather short dorsal crests, single or double, in ♂ often with lateral tufts on terminal segments. Posterior tibiae with all spurs present, in ♂ sometimes dilated, with a groove and pencil of hairs on inner side. Hindwing without rounded basal costal expansion, frenulum and retinaculum in ♂ well developed, in ♀, frenulum represented by a tuft of long hairs. Forewing:

R_1 from cell, free, or anastomosing with Sc, or with Sc and R_2; $R_{2-3-4-5}$ stalked, M_1 separate or connate, M_2 remote from M_1, M_3 and Cu_{1a} separate. Hindwing: Sc + R_1 approximated to cell near base, then rather rapidly diverging, Rs and M_1 separate, M_2 remote from M_1, M_3 and Cu_{1a} separate. Hindwings with tufts of raised scales on upper surface, in some species near base only, in others in terminal area also. The latter group usually with tufts of raised scales near the base of forewings.

Type, *Pingasa ruginaria* Guenée.

I agree with Turner that it is not necessary to divide this genus, although there are clearly two tribes, one in which the scale tufts are confined to the basal area of the hindwings, apparently of Asiatic origin, and the other with scale tufts near the base of the forewings, and extending into the subterminal area of the hindwings, largely developed in the Austro-Papuan region. Of the first group, one species only is as yet unknown beyond Australia.

Group 1. Hindwings in ♂ rather long and narrow, tornus somewhat produced, dorsum long. Scale tufts near base of hindwings only.

The species contained in this group and occurring in Australia, are clear white beneath, with more or less broad black areas along the termen in both wings In one species there is a yellowish suffusion towards the base and along the costa.

Key to Species.

1. Ground colour of wings grey above 2
   Ground colour of wings green above ..... *atriscripta*
2. Antemedian line of forewings forming two strongly rounded projections .... *cinerea*
   Antemedian line of forewings not so 3
3. Antemedian line of forewings with subcostal dentation connecting with discal spot ..... *blanda*
   Antemedian line of forewings not so 4
4. Subterminal areas above strongly suffused with reddish-brown or fuscous; posterior tibiae strongly dilated ..... *ruginaria*
   Subterminal areas irrorated only, with reddish-brown, posterior tibiae slightly dilated ..... *chlora*

13. PINGASA RUGINARIA. Pl. xv, fig. 8.

Hypochroma ruginaria, Guenée, *Spec. Gen. Lep.*, 9, 1858, 278.—*H. commutata*, Walker, *Cat. Lep. Brit. Mus.*, 21, 1860, 429.—*H. communicans*, Walker, *Cat. Lep. Brit. Mus.*, 21, 1860, 430.—*H. perfectaria*, Walker, *Cat. Lep. Brit. Mus.*, 21, 1860, 434.—*H. nyctemerata*, Walker, *Cat. Lep. Brit. Mus.*, 21, 1860, 444.—*H. grandidieri*, Butler, *Cist. Ent.*, 2, 1879, 394. Var.—*H. ruginaria*, Moore, *Lep. Ceylon*, 3, 1887, 419.—*Pingasa decristata*, Warren, *Nov. Zool.*, 9, 1902, 492.—*P. ruginaria*, Prout, *Gen. Insect.*, fasc. 129, 1912, 31.

This species has not hitherto been recorded from Australia. It appears to have less yellow towards the base beneath than more Western examples, but I can find no reason for separation. It bears a considerable resemblance to *P. chlora*, of which it might at first sight be taken for a variety, but the form of the second line is different, and the posterior tibiae are strongly dilated.

Q'land: Meringa (Nov., 1 ♂, Goldfinch), Kuranda (1 ♂ in Coll. Turner, and 1 ♀ from the same locality in the South Australian Museum). The species has a wide range, extending from West Africa to Formosa, and no doubt throughout the Malayan Archipelago, and to Papua.

14. Pingasa chlora. Pl. xv, fig. 9.

Phalaena chlora, Stoll, in Cramer, *Pap. Exot.*, 4, 1782, 233, t. 398, f. C.—*Terpna chlora*, Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 638.—*Pingasa chlora*, Prout, *Gen. Insect.*, fasc. 129, 1912, 31.

It seems unnecessary to give the full synonymy of this well-known and wide-ranging species. I have, therefore, given the original reference, together with Dr. Turner's, and Mr. Prout's in *Genera Insectorum* which supplies full references.

Queensland: Cape York (Barnard), Herberton, Atherton, Cairns, Herbert River, Townsville, Dunk Island, Palm Island, Rockhampton, Nambour, Brisbane, Mt. Tambourine, Stradbroke Island, Coolangatta.

15. Pingasa atriscripta. Pl. xv, fig. 1.

Pingasa atriscripta, Warren, *Nov. Zool.*, 6, 1899, 19.—*Hypochroma munita*, Lucas, *Proc. Roy. Soc. Q'land*, 16, 1901, 78.—*Pingasa atriscripta*, Prout, *Gen. Insect.*, fasc. 129, 1912, 33; Turner, *Trans. Roy. Soc. S. Aust.*, 46, 1922.

Q'land: Cape York (May, Barnard), Cairns.

This species is readily distinguished from the others of the group by its green colour, with black lines. I suspect that Warren's *P. angulifera*, from Fergusson Island, may be the female of this species.

16. Pingasa blanda. Pl. xv, fig. 2.

Pseudoterpna blanda, Pagens, *Zoologica*, 29, 1900, 151.—*Pingasa acutangula*, Warren, *Nov. Zool.*, 10, 1903, 352.—*P. blanda*, Prout, *Gen. Insect.*, fasc. 129, 1912, 33.—*P. acutangula*, Prout, *Gen. Insect.*, fasc. 129, 1912, 33.—*P. blanda*, Prout, *Nov. Zool.*, 23, 1916, 193.—*P. acutangula*, Turner, *Trans. Roy. Soc. S. Aust.*, 46, 1922, 280.

Q'land: Coen River, Kuranda, Meringa (Mar., Burns).

Easily separated from the other grey species by the extremely deep dentations of the lines, the dentation of the first line in the cell of the forewing extending to, and partly enclosing, the cell spot.

17. Pingasa cinerea. Pl. xv, fig. 3.

Pingasa cinerea, Warren, *Nov. Zool.*, 1, 1894, 382.—*Pseudoterpna singularis*, Kershaw, *Vict. Nat.*, 14, 1897, 104.—*Skorpisthes unda-scripta*, Lucas, *Proc. Roy. Soc. Q'land*, 15, 1900, 143.—*Terpna cinerea*, Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 639.—*Pingasa cinerea*, Prout, *Gen. Insect.*, fasc. 129, 1912, 33.

Q'land: Westwood, Nambour, Caloundra, Toowoomba, Brisbane; N. S. Wales: Mittagong (April, diminutive specimen); Victoria: Narracan.

The unusual rest attitude has been already remarked.

Group 2. Hindwings in ♂ rounded, tornus not produced. Scale tufts extending into the subterminal area of hindwings, and the base of forewings.

Key to Species.

1. Hindwings beneath bright orange towards the base 2
   Hindwings beneath not bright orange towards the base 3
2. Subterminal bands beneath bright purple ..... *multicolor*
   Subterminal bands beneath rich black ..... *emiliaria*
3. Face clothed with fine velvety projecting hairs ..... *paroptila*
   Face not so 4

4. Lower third of face free from scales, protruding, shining like varnish 5
   Lower third of face evenly scaled 6
5. Upperside brown or reddish-brown ..... *deteriorata*
   Upperside pale mossy green irrorated with fuscous ..... *calliglauca*
   Upperside green-whitish, lines fuscous with red blotches ..... *conspurcata*
6. Upperside rich mossy green 7
   Upperside not rich mossy green ..... *erebata*
7. Underside whitish, more or less mottled with fuscous; discal spots large; subterminal band broad and ill-defined ..... *muscosaria*
   Underside milky white, not mottled; discal spots of hindwing usually absent in ♂, linear in ♀; subterminal bands narrow, well defined ..... *bryophylla*

18. Pingasa emiliaria.

Hypochroma emiliaria, Guenée, *Spec. Gen. Lep.*, 9, 1858, 280.—*H. aurantiacea*, Lucas, Proc. Linn. Soc. N. S. Wales, (2) 6, 1891, 297.—*H. subornata*, Warren, *Nov. Zool.*, 3, 1896, 360.—*H. purpurifera*, Warren, *Nov. Zool.*, 6, 1899, 18.—*H. purpurissata*, Lucas, *Proc. Roy. Soc. Q'land*, 16, 1901, 77.—*H. assidens*, Lucas, *Proc. Roy. Soc. Q'land*, 16, 1901, 79.—*Terpna emiliaria*, Turner, Proc. Linn. Soc. N. S. Wales, 35, 1910, 636.—*Hypodoxa emiliaria*, Prout, *Gen. Insect.*, fasc. 129, 1912, 34.

Q'land: Prince of Wales Is., Thursday Is., Cape York, Cooktown, Cairns, Kuranda, Cardwell, Dunk Is., Stannary Hills, Herberton, Meringa, Gympie, Brisbane; N. S. Wales: Lismore.

19. Pingasa multicolor.

Hypochroma multicolor, Warren, *Nov. Zool.*, 6, 1899, 17.—*Hypodoxa multicolor*, Prout, *Gen. Insect.*, fasc. 129, 1912, 34.

Q'land: Cape York (Nov., Barnard).

Mr. Barnard's specimen, a ♂, is in poor condition, but I have little doubt as to the correctness of my determination. The species may be distinguished from *P. emiliaria*, which it resembles, by the different form of the second line of the forewings, the simple portion of the antennae being longer, and the rich purple subterminal lines beneath. The species was originally described from St. Aignan.

The following two species are remarkably similar and, except for a difference in size, and a certain distinctive appearance on the upper side, very difficult to define in a written description; they might well (as has been the case hitherto) be considered as forms of one rather variable species. I have carefully examined the genitalia and, as may be observed from Text-figures 1 and 2, there is evidence to establish a second species. The problem then arises as to which is the true *muscosaria* of Guenée. From a careful study of the original description of the ♂, and the figure of the ♀, I have come to the conclusion that the smaller species, usually found in more or less dry sandstone forest country, and ranging from Tasmania as far north as Ebor, is the true *muscosaria*, and that the larger species, ranging from Sydney northwards to Mackay (Q'land), is as yet undescribed. This conclusion is supported when one considers that, almost without exception, the whole of the Australian species described by Guenée were obviously received from sources either in Tasmania or South-Eastern Australia. Scarcely a single tropical or subtropical species of Geometer was described by him from Australian specimens, though there are many species named by him, but from examples captured in other countries. In order to simplify the determination of the two species it is hoped that the following table setting out the admittedly rather slender outward distinctions between the two, will be found helpful.

P. muscosaria Guenée.

Expanse. ♂, 32-38 mm.; ♀, 38-44 mm.

Markings. Upperside: lines rather indistinct, often represented by black dots on veins. Discal mark of forewing above straight.

Underside: whitish areas more or less mottled with grey scales.

Discal spot of forewing beneath large, round.

Discal spot of hindwing beneath oval.

Subterminal bands broad, the anterior margins ill-defined.

P. bryophylla, n. sp.

Expanse. ♂, 41-49 mm.; ♀, 52 mm.

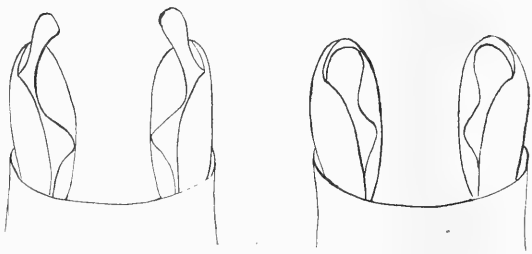
Markings. Upperside: lines clearly defined, discal mark of forewing above sinuate.

Underside: whitish areas scarcely mottled.

Discal spot of forewing beneath smaller, oval.

Discal spot of hindwing beneath linear or absent.

Subterminal bands narrower, well defined.



1 2

Text-fig. 1.—Genitalia of *Pingasa bryophylla*, ♂. Ventral aspect, showing *gonocoxites* or *valves*.

Text-fig. 2.—Genitalia of *Pingasa muscosaria*, ♂. Ventral aspect, showing *gonocoxites* or *valves*.

20. PINGASA MUSCOSARIA. Pl. xiv, fig. 14; Pl. xvi, fig. 5.

Hypochroma muscosaria, Guenée, *Spec. Gen. Lep.*, 9, 1858, 281, Pl. 6, f. 3.—*H. cetraria*, Felder, *Reise Novara*, Lep. Het., 1875, t. 125, f. 7, 7a.—*H. squamata*, Felder, *Reise Novara*, Lep. Het., 1875, t. 126, f. 14.

♂, 32-38 mm. ♀, 38-44 mm. Face green, irrorated towards the vertex with fuscous scales. Palpi: basal joint white, a black lateral mark towards the apex, second joint green above, whitish irrorated with fuscous and crimson scales beneath, terminal joint smooth, green. Thorax smooth, green, irrorated with fuscous scales, beneath densely hairy, abdomen with three or four double crests on the basal segments, green irrorated with fuscous scales, lateral tufts whitish. Legs: anterior pair, coxae beneath crimson, femur, tibiae and tarsi fuscous, the last ringed with whitish at the joints; median pair whitish, tibiae darker; posterior pair somewhat dilated, whitish. Forewings: mossy green, irrorated with fuscous, and often suffused with brownish; lines rather indistinct, fuscous, first from costa at about one-fourth to dorsum at one-third, three times curved outwards, sometimes preceded by a fuscous or brownish suffusion; a more or less obscure linear discal transverse mark; the second line from costa at before three-fourths, at right angles to costa, and dentated on each vein to vein M_3, thence curved inwards, dentate on each vein to dorsum at before two-thirds; a dentate whitish subterminal line from costa before apex to dorsum before tornus; an interrupted terminal fuscous line thickened between veins; cilia greenish-whitish, darker

towards the base. The discal and postmedian areas often suffused with fuscous or reddish-brown. Hindwings: colour and suffusions as in forewings; first line absent, discal mark obscure, linear, second line as in forewings. Beneath whitish, more or less mottled with fuscous, discal spot large, round; subterminal band fuscous, ill-defined, enclosing an incomplete series of subterminal dots. Hindwings as above, discal spot oval, present in both sexes, larger in ♀.

N. S. Wales: Ebor, Sydney (March, April, September, October, November, December), Blue Mts. (December), Mittagong (February), Mt. Kosciusko, 3000 feet; Victoria: (Ferntree Gully), Gembrook (November), Warburton; Tasmania: (Snug River) Hobart (January).

21. Pingasa bryophylla, n. sp. Pl. xiv, fig. 13; Pl. xvi, fig. 4.

♂, 41-49 mm. ♀, 52 mm. Face green, irrorated with fuscous scales. Palpi: basal joint whitish with a fuscous lateral mark towards the apex, second joint green, fringed beneath with whitish scales, terminal joint green.

Thorax smooth, green, irrorated with fuscous scales; beneath densely hairy. Abdomen green with three or four double crests on the basal segments, lateral tufts whitish. Legs: anterior pair, coxae greenish beneath, femur, tibiae and tarsi whitish, median and posterior pairs whitish. Forewings mossy green, irrorated with fuscous and suffused with reddish-brown, lines black, clearly defined, first from costa at about one-fourth to dorsum at one-third, three times curved outwards, preceded by a reddish suffusion, a distinct sinuate linear transverse discal spot, second line from costa at before three-fourths, at right angles to costa, and dentate on each vein to vein M_3, thence curved inwards, dentate on each vein to dorsum at about one-half; an obscure whitish subterminal dentate line from costa before apex to dorsum before tornus; an interrupted terminal fuscous line thickened between veins; cilia greenish, towards the base irrorated with fuscous scales. The area beyond the second line suffused with reddish. Hindwings: colour and reddish suffusions as in forewings, first line absent, discal mark obscure, second line as in forewings. Beneath, milky white, hardly mottled. Discal mark in forewings oval, somewhat thickened, in hindwings, often absent in ♂, very narrow linear or absent in ♀. Subterminal bands rather narrow, clearly defined, enclosing an incomplete series of white spots.

Q'land: Eungella, Brisbane, Toowoomba (September, March), Stanthorpe, National Park (2,500 ft.); N. S. Wales: Port Macquarie (April), Allyn River (December), Wentworth Falls (April), Sydney (April).

Holotype and allotype in collection Goldfinch.

22. Pingasa paroptila. Pl. xvi, fig. 7.

Pseudoterpna paroptila, Turner, *Trans. Roy. Soc. S. Aust.*, 30, 1906, 130.—*Terpna paroptila*, Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 638; Prout, *Gen. Insect.*, fasc. 129, 1912, 40; Turner, *Trans. Roy. Soc. S. Aust.*, 46, 1922, 281.

Through the kindness of Mr. G. Lyell I have had the opportunity to examine the type which still remains unique. The wings are tufted, but it differs from the other Australian species of this genus in the frons being clothed with fine and rather long velvety hairs, apparently somewhat as in *Dindica*. The type is in rather poor condition, antennae missing and the thoracic crests (if any) have been abraded. The first line being straight is unusual in the group.

23. Pingasa deteriorata. Pl. xiv, fig. 16; Pl. xvi, fig. 6.

Hypochroma deteriorata, Walker, *Cat. Lep. Brit. Mus.*, 21, 1860, 441.—*H. horridata*, Walker, *Cat. Lep. Brit. Mus.*, 26, 1862, 1544.—*Boarmia nigraria*, Felder, *Reise Novara*, Lep. Het., 1875, t. 126, f. 1.—*Terpna deteriorata*, Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 668.—*Hypodoxa deteriorata*, Prout, *Gen. Insect.*, fasc. 129, 1912, 34.

This and the two following species are closely related; indeed, I think it doubtful whether their separation is justified, but since, as far as is known, their separate types of markings remain constant within the known range of each form, there is reason to allow them to remain of specific rank. In each species the lower third of the face is bare of scales, roundly prominent, and shining black as though varnished. They are the only members of this group in which any marked peculiarity of the frons has been developed, although in the Boarmiidae and Oenochromidae such development is not at all unusual, particularly amongst those species found in the dry interior of Australia.

N. S. Wales: Sydney, Blue Mts., Mittagong.

24. Pingasa calliglauca. Pl. xiv, fig. 15.

Turner, *Trans. Roy. Soc. S. Aust.*, 50, 1926, 125.

Q'land: Westwood (Goldfinch), Toowoomba, Stanthorpe.

Dr. Turner informs me that the specimen recorded from Ebor, N.S.W., is really *P. muscosaria* Gn.

25. Pingasa conspurcata. Pl. xiv, fig. 17.

Hypochroma conspurcata, Lucas, *Proc. Roy. Soc. Q'land*, 13, 1898, 68.—*Pseudoterpna myriosticta*, Turner, *Trans. Roy. Soc. S. Aust.*, 28, 1904, 223.—*Terpna myriosticta*, Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 638.

I have examined Lucas's type which is undoubtedly conspecific with Turner's species, though the blotches beyond the second line are more red. The ♂ is unknown, but I have a specimen from Southport, Q'land, which I suspect may be the male. It is somewhat paler than Sydney specimens, and the vertex and upper part of the face are whitish.

26. Pingasa erebata. Pl. xvi, fig. 11.

Hypochroma erebusata, Walker, *Cat. Lep. Brit. Mus.*, 21, 1860, 443.—*H. erebata*, Meyrick, Proc. Linn. Soc. N.S.W., (2) 2, 1888, 914.—*Terpna erebata*, Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 638.—*Hypodoxa erebusata*, Prout, *Gen. Insect.*, fasc. 129, 1912, 35.

N. Aust.: Darwin; Q'land: Meringa, Duaringa, Yeppoon, Gympie, Caloundra, Brisbane, Southport.

8. Genus Terpna.

H.-Schaffer, *Samml. Aussereur. Schmett.*, 1, 1856, 26, 37.—*Hypochroma* (part), Guenée, *Spec. Gen. Lep.*, 9, 1858, 275.—*Pachyodes*, Guenée, *Spec. Gen. Lep.*, 9, 1858, 282.—*Pseudoterpna*, Meyrick, *Trans. Ent. Soc. Lon.*, 1889, 496.—*Absala*, Swinhoe, *Ann. Mag. Nat. Hist.*, (6) 12, 1893, 149.—*Archaeopseustes*, Warren, *Nov. Zool.*, 1, 1894, 380.—*Calleremites*, Warren, *Nov. Zool.*, 1, 1894, 384.—*Psilostagma*, Warren, *Nov. Zool.*, 1, 1894, 678.—*Terpna* (part), Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 634; *Terpna*, Prout, *Gen. Insect.*, fasc. 129, 1912, 38; *Terpna*, Turner, *Trans. Roy. Soc. S. Aust.*, 46, 1922, 281.

Face smooth, sometimes somewhat prominent. Tongue well developed. Palpi moderate or long, porrect or ascending, basal and second joints densely rough-scaled beneath, terminal joint moderately smooth. Antennae in ♂ bipectinate,

towards apex simple, in ♀ simple. Thorax smooth or slightly crested, beneath hairy. Abdomen with dorsal crests, or smooth, in ♂ often with lateral tufts on the terminal segments. Posterior tibiae with all spurs present, in ♂ sometimes dilated with a groove and tuft of hairs on inner side. Hindwing without basal costal expansion, frenulum and retinaculum in ♂ strongly developed, in ♀ frenulum represented by a tuft of hairs more or less strongly developed. Forewings: R_1 from cell and free, $R_{2-3-4-5}$ stalked from cell, M_1 separate, M_2 remote from M_1, M_3 and Cu_{1a} separate. Hindwings: Sc + R_1 approximated to cell near base, and rapidly diverging, Rs and M_1 separate, M_3 and Cu_{1a} separate. Discocellulars angled on vein M_2.

Type, *T. haemataria* H.-Sch., from India.

Key to Species.

1. Upperside ochreous, sometimes slightly tinged with greenish 2
   Upperside green 3
2. Abdomen with three strong abdominal crests, markings beneath black. Expanse 28-34 mm. ..... *melaleucae*
   Abdomen with two strong abdominal crests, markings beneath usually crimson. Expanse 34-44 mm. ..... *quadrilinea*
3. Beneath with basal areas of both wings orange ..... *saturataria*
   Beneath not so 4
4. Beneath with more or less broad crimson subterminal bands 5
   Beneath whitish or pale ochreous, with more or less heavy fuscous markings 6
5. Terminal line of both wings above, complete, continuous ..... *subrubescens*
   Terminal line absent from both wings ..... *viridicata*
6. Upper side more or less suffused with pink 7
   Upper side without pink suffusion, at most scattered reddish scales on the veins .. 8
7. Hindwings with subcostal area suffused with pink, forewings with two small subterminal pink blotches ..... *metarhodata*
   Both wings mostly suffused with pink ..... *rhodochlora*
8. Antennae in ♂ with strong scale notch at base ..... *hypochromaria*
   Antennae not so 9
9. Face and thorax spotted with back, wings with no reddish scales ..... *mniaria*
   Face and thorax not spotted with black, reddish scales on veins ..... *unitaria*

27. Terpna viridicata. Pl. xiv, fig. 12.

Hypochroma viridicata, Lucas, Proc. Linn. Soc. N.S.W., (2) 4, 1890, 1094.—*Terpna viridicata*, Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 641.—*Aeolochroma viridicata*, Prout, *Gen. Insect.*, fasc. 129, 1912, 36.—*Pingasa viridicata*, Turner, *Trans. Roy. Soc. S. Aust.*, 50, 1926, 125.

Q'land: Buderim Mt. near Nambour, Brisbane, Bunya Mts.; N. S. Wales: Pt. Macquarie (April, Goldfinch).

I have no ♂ for examination, but Dr. Turner informs me that the species is correctly placed in this genus, there being no tufts of raised scales on the wings other than the discal spot of the forewings.

This species is the most perfect imitation of the kind of lichen that one finds growing in small patches on the trunks of smooth barked rain forest trees that I have ever seen. At Port Macquarie I had the good fortune to find a freshly emerged ♀ which an experienced observer failed to perceive after having been told that a moth was on the stump.

28. Terpna hypochromaria. Pl. xiv, figs. 5, 6.

Cleora ? hypochromaria, Guenée, *Spec. Gen. Lep.*, 9, 1858, 234.—*Hypochroma hypochromaria*, Meyrick, Proc. Linn. Soc. N.S.W., (2) 2, 1888, 909.—*Pseudoterpna*

bryophanes, Turner, *Trans. Roy. Soc. S. Aust.*, 28, 1904, 222.—*Terpna hypochromaria*, Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 641.—*Aeolochroma hypochromaria*, Prout, *Gen. Insect.*, fasc. 129, 1912, 36.—*Terpna hypochromaria*, Turner, *Trans. Roy. Soc. S. Aust.*, 46, 1922, 282.

The unusual notch at the base of the antennae is pointed out by Turner. A somewhat similar, but much smaller structure is present in *T. unitaria*.

Q'land: Cape York, Gayndah, Nanango, Brisbane, Toowoomba, Bunya Mts., Coolangatta; N. S. Wales: Lismore, Pt. Macquarie, Sydney, Stanwell Park.

29. Terpna subrubescens. Pl. xv, figs. 17, 18.

Hypochroma subrubescens, Warren, *Nov. Zool.*, 3, 1896, 101.—*Terpna subrubescens*, Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 642.—*Aeolochroma subrubescens*, Prout, *Gen. Insect.*, fasc. 129, 1912, 37.

Q'land: Townsville, Mackay, Westwood, Bundaberg, Toowoomba.

30. Terpna unitaria. Pl. xiv, fig. 18; Pl. xv, fig. 19; Pl. xvi, fig. 8.

Tephrosia unitaria, Walker, *Cat. Lep. Brit. Mus.*, 21, 1860, 417.—*Hypochroma acanthina*, Meyrick, Proc. Linn. Soc. N.S.W., (2) 2, 1888, 910.—*Terpna acanthina*, Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 641.—*Aeolochroma unitaria*, Prout, *Gen. Insect.*, fasc. 129, 1912, 36.—*Terpna unitaria*, Turner, *Trans. Roy. Soc. S. Aust.*, 46, 1922, 281.

Q'land: Duaringa, Toowoomba; Tasmania.

Prout, who has no doubt seen both Walker's and Meyrick's types, is of the opinion that they represent one species. There is a male, 42 mm. (Pl. xvi, fig. 8) in the Macleay Museum at the Sydney University labelled "Tasmania", which would quite well agree with Walker's very loose description. It is, unfortunately, in poor condition, being much faded, the whole of one and most of the other antenna broken off and the thoracic and abdominal crests (if any) abraded. This, I believe, may be the typical *unitaria* of Walker. I have also, for examination, two male specimens from Toowoomba which agree exactly with Meyrick's description. Whilst the Toowoomba specimens and the Tasmanian one resemble one another rather closely, I would not be too confident in asserting that they were conspecific. I have no knowledge of the condition of Walker's type, but have figured both the Toowoomba and the Tasmanian specimens in the hope that some worker in England may be able to settle the point. For the present I am content to follow Prout, but have little doubt that when fresh material is obtained from Tasmania, *acanthina* will be restored to specific rank.

31. Terpna saturataria. Pl. xiv, figs. 3, 4.

Hypochroma saturataria, Walker, *Cat. Lep. Brit. Mus.*, 35, 1866, 1593.—*H. perfulvata*, Warren, *Nov. Zool.*, 6, 1899, 326.—*Pseudoterpna saturataria*, Swinhoe, *Lep. Het. Oxf. Mus.*, 2, 1900, 384, t. 5, f. 6.—*Hypochroma saturataria* ab. *perviridata*, Warren, *Nov. Zool.*, 10, 1903, 351.—*Aeolochroma saturataria*, Prout, *Gen. Insect.*, fasc. 129, 1912, 36.—*Terpna saturataria*, Turner, *Trans. Roy. Soc. S. Aust.*, 46, 1922, 281.

Q'land: Cape York (Barnard).

This species is readily distinguished from the other mossy green species by the basal areas of the wings beneath being coloured rich orange, the subterminal areas being fuscous.

32. TERPNA MNIARIA, n. sp. Pl. xiv, figs. 1, 2.

♂, 34-38 mm. ♀, 36-42 mm. Face black, with a broad white band above middle and a narrow white band along the lower edge, vertex greenish-white. Palpi: basal segment white, with a black lateral spot towards apex, second joint black with whitish scales at apex, terminal joint black, rather short. Antennae: basal joint white, the shaft and pectinations fuscous. Thorax: patagiae green with a black spot between, tegulae black at base, otherwise green, thorax green, with two longitudinal curved black marks, a few spreading green scales tending to form a small posterior crest, hairy beneath. Abdomen whitish-green, with a double row of black spots on segments one to four, usually two small green crests, lateral tufts on posterior segments whitish, anal tuft whitish. Legs: anterior and median pairs fuscous, blotched with whitish and ringed at joints of tarsi; posterior pair whitish irrorated with black. Forewings green, irrorated with fuscous, extreme costal edge white, heavily strigulated with black, lines black; a short black dash at base, a series of disconnected black spots from costa close to base to dorsum; first line from costa before one-fourth to dorsum before one-third, three times curved outwards, discal spot black, whitish centred; second line from costa before three-fourths, angulated below costa, thence curved outwards and dentate to vein Cu_{1a} below which it curves inwards to dorsum at about two-thirds, followed posteriorly by a fine white line interrupted in middle; an indistinct whitish fine subterminal line from costa before apex to dorsum before tornus, enclosing five or six black wedge-shaped spots below costa; an interrupted black terminal line, forming lunules between the veins; cilia white barred with black at vein endings. A blackish suffusion usually present from middle of second line to termen, and a similar suffusion above tornus. Hindwings: colour as forewings, first line absent, discal spot black, second line as in forewings, subterminal line whitish, not continuous, enclosing two black spots above the tornus, and a large double spot above middle. Terminal line and cilia as in forewing. Beneath, white, more or less densely irrorated with fuscous blotches, broad fuscous subterminal bands enclosing in the forewings a series of small white dots, and at apex and middle of termen, obscure whitish blotches; first and second lines as above, discal dots black.

N. S. Wales: Sydney (July), Mittagong (November, December, March); Victoria: Lorne (March, Lyell).

Holotype and allotype in collection Goldfinch.

The species seems to be rare, except at Mittagong where it is taken rather commonly at night with a lamp. This species, along with several others of the group, is commonly found resting on the foliage of the Native Cherry (*Exocarpus*).

33. TERPNA RHODOCHLORA, n. sp. Pl. xvi, fig. 18.

♀, 32 mm. Face pale green, slightly pinkish tinged. Palpi: basal joint white, clothed with long scales becoming fuscous towards the tips, second and terminal joints black, clothed above with long crimson scales. Antennae reddish-brown, heavily barred with black towards the base; thorax pale green, pinkish in the centre; abdomen pink, with scattered greenish fuscous scales. Legs: anterior coxae crimson anteriorly, tibiae and tarsi fuscous, barred with pinkish ochreous, middle legs absent (broken), posterior pair ochreous irrorated with fuscous dots. Forewings pale green, broadly suffused with pale pink (it is difficult to decide whether to call the wings pink with green suffusions or the reverse, but the ♂, when discovered, will probably show that the ground colour is really green), irrorated and strigulated along the costa with greenish fuscous. Lines black, an

indistinct black transverse bar near base, first line from costa at about one-sixth, slightly outwards bowed in cell to dorsum at about one-third, an elongate linear black discal spot, second line from costa at about three-fourths, almost straight to vein M_3, thence three times curved inwards to vein 1A + 2A, thence outwards to dorsum at about two-thirds, an indistinct white dentate subterminal line from costa before apex not reaching the tornus; a fine black terminal line; cilia fuscous with a pale central line. The pink suffusion almost replaces the green colour in a large central area enclosing the discal spot, and before the apex and above the tornus. Hindwings: as in forewings, basal bar and first line absent; discal spot very elongate, linear; subterminal and terminal lines and cilia as in forewings. Beneath, forewings ochreous whitish, towards the base suffused with pinkish and irrorated with fuscous, first and second lines present, discal spot consists of an elongate double mark; beyond the second line a broad fuscous suffusion, becoming crimson towards the outer margin, and beneath the apex, but not reaching the tornus. Hindwing as forewing, but discal spot is not double.

Lismore, N. S. Wales, 1 ♀, received from Mr. Robinson.

Type in collection Goldfinch.

This species somewhat resembles *T. metarhodata*, but may be distinguished by the different shape of the second line in both wings, the discal spot being linear, and the crimson subapical suffusion beneath. It is probably nearest to *T. subrubescens*, from which it differs in the shape of the first and second lines.

34. Terpna metarhodata. Pl. xv, fig. 7.

Scotosia metarhodata, Walker, *Cat. Lep. Brit. Mus.*, 26, 1862, 1724.—*Hypochroma metarhodata*, Meyrick, Proc. Linn. Soc. N.S.W., (2) 2, 1888, 908.—*Terpna metarhodata*, Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 640.—*Aeolochroma metarhodata*, Prout, *Gen. Insect.*, fasc. 129, 1912, 36.

Q'land: Gayndah, Brisbane; N. S. Wales: Port Macquarie, Newcastle, Sydney, Woodford; Victoria: Sale, Melbourne.

35. Terpna quadrilinea. Pl. xv, fig. 13.

Hypochroma quadrilinea, Lucas, *Proc. Roy. Soc. Q'land*, 8, 1892, 80.—*Actenochroma ochrea*, Warren, *Nov. Zool.*, 3, 1896, 360.—*Hypochroma ochrea*, Warren, *Nov. Zool.*, 4, 1897, 207.—*Pseudoterpna quadrilinea*, Swin., *Trans. Ent. Soc. Lond.*, 1902, 669.—*Terpna quadrilinea*, Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 642.—*Aeolochroma quadrilinea*, Prout, *Gen. Insect.*, fasc. 129, 1912, 36.

♂, 34-38 mm. ♀, 40-44 mm. Face white, sometimes ochreous tinged, a red spot on each side above lower margin; antennae ochreous-white; palpi over 2, basal joint white, second joint crimson, beneath white; terminal joint one-half, crimson; thorax and abdomen ochreous-white, two strong rounded crests on third and fourth segments and often minute crests on fifth and sixth segments, in ♂ lateral tufts on terminal segments. Legs: anterior pair white or brownish tinged, median pair white, with crimson spot on apex of femur, posterior pair white, hardly dilated. Forewings: ochreous-whitish, sparsely irrorated with brownish-fuscous scales, markings very obscure, often obsolete; a few brown strigulae along costa, first line, when present, from a fuscous blotch on costa at about one-fourth, more or less straight to dorsum at before middle, more often in the ♀ followed by an obscure brownish suffusion, strongest towards the dorsum; discal

spot represented by a few lead-coloured scales surrounded by a few fuscous scales, sometimes obsolete, second line obscure, often obsolete, from costa at about three-fourths, curved inwards below costa, thence curved outwards and waved to dorsum before tornus, usually followed by an obscure brownish suffusion containing two brown dashes above middle, and sometimes a rounded brownish blotch above tornus; subterminal line usually absent, cilia whitish-ochreous, sometimes barred with brownish in middle. Often a distinct brown or fuscous spot between discal spot and mid costa. Hindwings: colour as in forewings, first line absent, sometimes an obscure discal pale fuscous spot; second line very indistinct, indicated by a series of brownish or fuscous spots on veins; sometimes a very obscure subterminal brownish-fuscous suffusion, cilia whitish ochreous. Beneath ochreous-whitish, markings crimson. Forewings: discal spot black, edged with crimson, second line from costa well beyond origin of vein R_4, to above dorsum before tornus, followed by a broad crimson suffusion, somewhat mixed with fuscous above middle, not reaching termen. A longitudinal crimson blotch below cell. Hindwings: discal spot and second line crimson, a broad crimson subterminal band. The crimson markings of the underside are sometimes replaced by brownish fuscous.

Q'land: Meringa (June and July, 2 ♀), Yeppoon (November, 1 ♂), Rockhampton (October, 1 ♀); N. S. Wales: Lismore (February, 1 ♀), Port Macquarie (2 ♀), Sydney (December, January and March, 6 ♂).

The above localities are from the specimens in my own collection. The species is also known from the following additional localities: Q'land: Kuranda, Mackay, Gayndah, Brisbane; N. S. Wales: Byron Bay.

The species is attached to *Melaleuca leucadendron*, but may feed on other paper bark trees. In two ♀ specimens from Meringa the first line is followed by a broad brownish-crimson suffusion.

36. Terpna melaleucae, n. sp. Pl. xv, fig. 14.

♂, 28-33 mm. ♀, 32-34 mm. Face white, a narrow black bar below middle; vertex ochreous-whitish, antennae grey, palpi less than 2, basal joint white, second joint black laterally and beneath, above whitish-ochreous, hairy, terminal joint very short, ochreous. Thorax smooth, ochreous-whitish, usually slightly tinged with greenish; abdomen with three strong, rounded dorsal crests on second, third and fourth segments, ochreous-whitish, irrorated with black scales, in ♂ lateral tufts on terminal segments. Legs: anterior pair ochreous, the tarsal joints ringed with black, median pair ochreous-whitish with a distinct black spot on the inner side at the apex of the femur, posterior pair whitish-ochreous, hardly dilated. Forewings triangular, termen evenly bowed, ochreous, often slightly greenish tinged, sparsely irrorated with black scales, markings often rather obscure, fuscous; costa strigulated with short fuscous marks to near apex, usually a minute black dash at base, first line from an elongate black spot on costa at beyond one-fourth, curved outwards to beyond middle of cell, thence almost straight to dorsum at before one-half, discal spot obscure, elongate, composed of leaden-coloured scales surrounded by fuscous scales; second line from a black spot on costa at before three-fourths, curved outwards to vein M_3, thence usually obscure to dorsum just before tornus, followed in middle by a thin leaden-coloured line; usually a very indistinct whitish-ochreous waved subterminal line from before apex to above tornus, between this and second line usually an obscure brownish suffusion; a more or less complete series of black terminal

dots between the veins. A brownish-fuscous shade following the first line is often present above the dorsum. Hindwings: colour as forewings, first line absent, a very obscure linear fuscous discal spot; second line often indistinct, but always marked by a series of black dots on the veins, a very obscure pale whitish-ochreous subterminal line usually with a suffused brownish blotch above middle of termen. Terminal black spots and cilia as in the forewings. Beneath, forewing whitish, costa heavily blotched with black, except towards the apex, discal spot large, black; second line arising from point of origin of vein R_4, almost reaching the dorsum, followed by a broad fuscous suffusion, sometimes pinkish tinged; between this and the termen, usually two obscure fuscous suffusions above and below middle. A broad longitudinal fuscous blotch, sometimes tinged with pink below cell. Hindwing whitish, first line absent, discal spot large, black, second line from costa before apex to dorsum, followed by a broad irregular sometimes pinkish tinged fuscous band not reaching the termen.

Q'land: Gayndah, Brisbane; N. S. Wales: Port Macquarie (April, 1 ♂, 3 ♀), Richmond (September, 1 ♂), Mittagong (November and March, 5 ♂).

Holotype and allotype in collection Goldfinch.

For a long time I have been in doubt as to whether the separation of this species from *T. quadrilinea* could be justified. One felt a certain amount of diffidence in basing a new species on the presence of an extra abdominal crest and slight differences in coloration and size. However, I believe that the differences

3 4

Text-fig. 3.—Genitalia of *Terpna melaleucae*, ♂. Lateral aspect. Note the slender *gonocoxites* and the comparatively few bristles composing the *harpes*.
Text-fig. 4.—Genitalia of *Terpna quadrilinea*, ♂. Lateral aspect. Note the strong and heavy *gonocoxites* and the many and strong bristles forming the *harpes*.

disclosed by a study of the genitalia (Text-figures 3 and 4) leave no room for doubt as to the existence of two separate but closely allied species having the same general habit. This species is also attached to *Melaleuca*, as the name implies, but apparently to a different species of the plant genus.

9. Genus Aeolochroma.

Prout, *Gen. Insect.*, fasc. 129, 1912, 35; Turner, *Proc. Roy. Soc. S. Aust.*, 46, 1922, 281.

Face slightly projecting, palpi moderate, obliquely ascending, basal joint long haired beneath, second joint slightly hairy beneath, terminal joint smooth, rather short. Tongue developed. Antennae in ♂ slightly serrate, ciliated in tufts, in ♀ simple. Thorax not crested, beneath densely hairy. Abdomen with several median dorsal crests, terminal segments with lateral tufts. Posterior tibiae with all spurs present, not dilated. Hindwings without basal costal expansion; frenulum and retinaculum in ♂ well developed, in ♀ represented by a tuft of long hairs.

Forewings: R_1 free from cell or anastomosing with Sc and R_2, $R_{2-3-4-5}$ stalked from apex of cell, M_1 separate, M_3 and Cu_{1a} separate. Hindwings with Sc + R_1 approximated to cell near base, diverging before middle, Rs and M_1 separate, M_3 and Cu_{1a} separate.

Type, *Aeolochroma turneri* Warren.

37. Aeolochroma turneri. Pl. xvi, figs. 9, 10.

Hypochroma turneri, Lucas, Proc. Linn. Soc. N.S.W., (2) 4, 1890, 1096.—*Actenochroma turneri*, Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 633.—*Aeolochroma turneri*, Prout, *Gen. Insect.*, fasc. 129, 1912, 36; Turner, *Proc. Roy. Soc. S. Aust.*, 46, 1922, 281.

Q'land: Kuranda (May and June), Meringa (November), Mackay. Also from New Guinea.

10. Genus Oenochlora.

Warren, *Nov. Zool.*, 3, 1896, 353.—*Euarestus*, Lucas, *Proc. Roy. Soc. Q'land*, 15, 1900, 142.—*Oenochlora*, Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 643; Prout, *Gen. Insect.*, fasc. 129, 1912, 57.

Face smooth. Tongue well developed. Palpi stout, rather long, obliquely ascending; second joint smooth, or only slightly roughened beneath; terminal joint stout and rather short in both sexes. Antennae in ♂ pectinated nearly to apex; in ♀ serrate. Thorax and abdomen not crested; thorax densely hairy beneath, abdomen in ♂ with slight lateral tufts on terminal segments. Posterior tibiae with all spurs present; in ♂ strongly dilated with internal groove and tuft. Hindwings without basal costal expansion; frenulum and retinaculum in ♂ well developed; frenulum in ♀ represented by a tuft of long hairs. Forewings: R_1 from cell anastomosing strongly with Sc and R_2, sometimes the anastomosis with Sc is replaced by a short connecting bar, $R_{2-3-4-5}$ stalked, M_1 separate, M_3 and Cu_{1a} separate. Hindwings: Sc + R_1 closely approximated to cell to beyond middle, Rs and M_1 separate, M_3 and Cu_{1a} separate. Discocellulars not angled, but rather strongly curved inwards, only slightly oblique.

Type, *O. imperialis* Warren.

I agree with Turner that this genus should be placed in Group 2 in Prout's classification.

38. Oenochlora imperialis.

Warren, *Nov. Zool.*, 3, 1896, 354.—*Euarestus nobilitans*, Lucas, *Proc. Roy. Soc. Q'land*, 15, 1900, 142.—*E. patrocinatus*, Lucas, *Proc. Roy. Soc. Q'land*, 15, 1900, 142.—*Oenochlora imperialis*, Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 644; Prout, *Gen. Insect.*, fasc. 129, 1912, 57.

Q'land: Cooktown, Cairns, Kuranda, Eungella, Nambour, Brisbane, Mt. Tambourine, National Park (3,000 ft.); N. S. Wales: Lismore.

11. Genus Cyneoterpna.

Prout, *Gen. Insect.*, fasc. 129, 1912, 43.—*Autanepsia*, Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 629 (*praeocc.*, Turner, 1908).

Face clothed with long projecting hairs, an anteriorly directed crest on crown. Tongue well developed. Palpi rather long, porrected, basal and second joints densely hairy beneath, terminal joint long in both sexes. Antennae in ♂ bipectinated, apices simple; in ♀ simple. Thorax not crested, beneath densely

hairy, tegulae clothed with extremely long hairs, exceeding posterior edge of thorax. Abdomen with dorsal crests slightly indicated by some loose spreading hairs, terminal segments in ♂ with lateral tufts. Posterior tibiae with all spurs present, not dilated. Forewings in ♂ with frenulum and retinaculum well developed, in ♀ represented by a strong tuft of hairs. Forewings: R_1 from cell anastomosing with Sc and R_2, $R_{2-3-4-5}$ stalked from cell from well before angle, M_1 and M_2 approximated or connate, M_3 and Cu_{1a} remote. Hindwings, termen strongly toothed on veins M_3-Cu_{1a}-Cu_{1b}-2A. Sc + R_1 approximated to cell to middle, diverging rather rapidly, Rs and M_1 separate, Rs from well before angle, M_1 and M_2 closely approximated or connate, M_3 and Cu_{1a} widely separate; dorsal discocellular strongly curved inwards.

Type, *Hypochroma wilsoni* Felder.

Allied to the following genus.

Key to Species.

Upper side fuscous grey, strongly pinkish tinged, subterminal black blotch absent from forewings beneath ..... *alpina*

Upper side silvery grey, cilia only, pinkish tinged, terminal black blotch present on forewings beneath ..... *wilsoni*

39. Cyneoterpna wilsoni. Pl. xv, fig. 10.

Hypochroma wilsoni, Felder, *Reis. Novara*, 1875, t. 125, fig. 4, 4*a*.—*Autanepsia wilsoni*, Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 630.—*Cyneoterpna wilsoni*, Prout, *Gen. Insect.*, fasc. 129, 1912, 43; Turner, *Trans. Roy. Soc. S. Aust.*, 44, 1922, 279.

Q'land: (Stannary Hills) Herberton; N. S. Wales: Allyn River (December, 1 ♂); Victoria: Gisborne (October, 1 ♂, 1 ♀), Melbourne.

40. Cyneoterpna alpina, n. sp. Pl. xv, fig. 12.

♂, ♀. 50-52 mm. Face fuscous, a darker transverse bar in middle, vertex dark grey; palpi, basal joints grey irrorated with long black hairs, terminal joint black with a few whitish scales towards apex; antennae whitish, ringed with black, pectinations fuscous; thorax and abdomen greyish fuscous, the abdomen with traces of a double black dorsal line, lateral tufts and anal tuft pinkish tinged. Legs fuscous, whitish ringed at joints. Forewings fuscous grey, tinged throughout with pink, markings obscure, darker fuscous; first line from costa at about one-fifth, outwards to below about middle of cell, thence inwards to vein 1A + 2A, thence again outwards to form a double-toothed projection, thence inwards to dorsum before one-third, discal spot obscure, fuscous; second line from costa at about four-fifths, dentate to vein Cu_{1b}, thence deeply indented to form a double notch, thence again outwards to vein 1A + 2A, thence inwards again to dorsum at about two-thirds; vein 1A + 2A usually clothed with fuscous scales; an obscure whitish subterminal line from costa before apex, waved to dorsum near tornus; a fine pale fuscous terminal line with fuscous dashes between the veins; cilia grey, pink towards the tips. Hindwings as forewings, first line absent, discal spot obscure, linear; second and subterminal lines as in forewings, terminal line with dashes reduced to dots, cilia pinker. Beneath, forewings smoky grey, paler towards the base and dorsum, beyond the end of the cell pinkish tinged; hindwings, towards the base whitish, slightly pinkish tinged, a large black blotch from costa before apex to above tornus, preceded by a slender pink line not reaching the dorsum, and followed by a narrow white subterminal line, the area between which and the termen suffused with pink.

N. S. Wales: Mt. Koscuisko (5,000 ft., December, 2 ♂, 1 ♀). There is a third ♂ in the Australian Museum collection.

Holotype and allotype in collection Goldfinch.

Whilst closely resembling *C. wilsoni*, the venation differs in the following respects: Forewing: R_1 arises from cell from well before the origin of the stalk of $R_{2-3-4-5}$, and is not closely approximated as in *C. wilsoni*. M_1 and M_2 are very closely approximated or connate, but in *C. wilsoni* they are only moderately approximated. Hindwing: M_1 and M_2 are connate, whereas in *C. wilsoni* they are well separated.

The presence of a large black blotch on the underside of the forewings in *C. wilsoni*, is a further point of distinction, this being absent in *C. alpina*.

12. Genus Paraterpna, n. gen.

Face hairy. Tongue well developed, palpi rather short, basal and second joints densely hairy beneath, terminal joint in ♂ short, in ♀ longer. Antennae in ♂ bipectinated almost to apex, pectinations very short. Thorax with a slight anterior crest, tegulae clothed with extremely long hairs, exceeding posterior edge of thorax, beneath densely hairy. Abdomen with three or four rather strong dorsal crests, in ♂ with lateral tufts on terminal segments. Posterior tibiae with all spurs present, in ♂ somewhat dilated. Hindwings without basal costal expansion, frenulum and retinaculum in ♂ well developed, frenulum in ♀ represented by a strong tuft of hairs. Forewings with R_1 from cell anastomosing with Sc and sometimes with R_2, $R_{2-3-4-5}$ stalked from well before angle of cell, M_1 separate, M_2 remote from M_1, M_3 and Cu_{1a} remote. Hindwings with termen strongly toothed on veins M_3-Cu_{1a}-Cu_{1b}-2A; Sc + R_1 approximated to cell to about middle, thence diverging rather abruptly, Rs and M_1 connate or closely approximated, M_2 remote, M_3 and Cu_{1a} separate. Dorsal discocellulars curved inwards.

Type, *Paraterpna harrisoni*, n. sp.

Closely allied to the preceding genus, from which it differs in the smoother face, absence of the frontal crest, presence of rather strong abdominal crests, the very short antennal pectinations and the wide separation of veins M_1 and M_2 in both wings.

41. Paraterpna harrisoni, n. sp. Pl. xv, fig. 11.

♂, ♀. 52-60 mm. Face fuscous, lower margin narrowly, and upper margin broadly grey, vertex grey-whitish; thorax grey-whitish, clothed with long scales, a small anterior crest, beneath densely hairy; abdomen grey-whitish, with a series of black crests along the middle, forming an almost continuous black line, lateral and terminal tufts ochreous. Legs whitish-grey irrorated with fuscous scales, the posterior pair with groove and a hair pencil of pink hairs. Antennae white, with a fuscous transverse mark at the base of each segment, pectinations 1, yellow. Forewings greyish-white, sparsely irrorated with fuscous scales, but more heavily along the veins which appear fuscous; lines fuscous, first line from costa at one-fourth, sharply angulated outwards immediately below costa, thence three times extremely acutely dentate to dorsum at about one-third, discal spot small, fuscous, triangular, enclosing a few greyish scales, second line from costa at beyond three-fourths, dentate on each vein to vein M_3, which dentation projects the furthest, thence inwards to a point between veins Cu_{1b} and 1A + 2A below middle of cell, thence again sharply outwards to vein 1A + 2A near tornus, and then inwards curved to dorsum before tornus; a very faint terminal whitish line

from costa before apex to dorsum near tornus; a fine fuscous subterminal line; cilia greyish-white, slightly infuscated at vein endings. Hindwings white, towards the termen broadly suffused with grey scales, the veins lined with fuscous scales, first line absent, discal spot linear, fuscous; second and subterminal lines faintly indicated, terminal line and cilia as in forewing. Beneath white, first line absent, discal spot linear, second line present, not reaching dorsum, closely followed by a large fuscous blotch, not reaching costa or dorsum, hindwings similar.

N. S. Wales: Barrington Tops (5,000 ft., January, 1 ♂, 1 ♀).

Holotype and allotype in collection Goldfinch.

13. Genus Epipristis.

Meyrick, Proc. Linn. Soc. N.S.W., (2) 2, 1888, 916; Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 631; Prout, *Gen. Insect*, fasc. 129, 1912, 29; Turner, *Trans. Roy. Soc. S. Aust.*, 46, 1922, 282.

Face smooth, rounded. Tongue well developed. Palpi moderate, porrect; second joint smooth above, smooth or slightly hairy beneath; terminal joint stout, moderate, somewhat longer in ♀. Antennae simple in both sexes; ciliations in ♂ minute. Thorax not crested, smooth or slightly hairy beneath. Abdomen smooth or with small crests. Posterior tibiae with all spurs present; in ♂ not dilated. Hindwings without costal expansion at base; frenulum and retinaculum in ♂ well developed; frenulum in ♀ represented by a tuft of long hairs. Forewings: R_1 from cell, anastomosing with Sc and sometimes with R_2; $R_{2-3-4-5}$ stalked, M_1 separate, M_3 and Cu_{1a} separate but closely approximated at origin. Hindwing: Sc + R_1 approximated to cell at a point near base, thence rapidly diverging, Rs and M_1 separate, M_3 and Cu_{1a} separate but closely approximated at origin. Discocellulars nearly straight.

42. Epipristis minimaria. Pl. xvi, fig. 14.

Hypochroma minimaria, Guenée, *Spec. Gen. Lep.*, 9, 1858, 279.—*H. parvula*, Walker, *Cat. Lep. Brit. Mus.*, 21, 1860, 435.—*Acidalia truncataria*, Walker, *Cat. Lep. Brit. Mus.*, 23, 1861, 774.—*Pingasa minimaria*, Moore, *Lep. Ceylon*, 3, 1887, 420, t. 192, f. 2.—*Epipristis minimaria*, Swin., *Trans. Ent. Soc. Lond.*, 1894, 171.—*Pseudoterpna minimaria*, Hamps., *Fauna India*, Moths, 3, 1895, 479.—*Epipristis oxycyma*, Meyrick, Proc. Linn. Soc. N.S.W., (2) 2, 1888, 916.—*E. minimaria*, Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 632; Prout, *Gen. Insect.*, fasc. 129, 1912, 29.

Northern Australia: Darwin; Queensland: Cape York (June and August), Kuranda, Duaringa.

43. Epipristis australis, n. sp. Pl. xvi, fig. 13.

♂, ♀. 32-39 mm. Face velvety-black, extreme upper margin white or pale greenish; palpi white; vertex and thorax pale green, the latter without crests; abdomen greenish-white, irrorated with brownish scales, with two small whitish crests on the middle segments. Legs: anterior pair pale fuscous, median and posterior pairs whitish-ochreous, all spurs present, in ♂ somewhat dilated. Forewings whitish, in ♂ rather heavily and in the ♀ moderately irrorated with pale green scales, lines dark brownish fuscous. First line from costa at beyond one-fourth, four times angulated outwards, to dorsum at about one-fourth; second line from costa at beyond one-half, evenly curved outwards to vein Cu_{1a}, thence gently inwards to dorsum at beyond middle; posteriorly from this line each vein

is marked by a short dash; an obscure whitish waved subterminal line from costa before apex to dorsum before tornus, between this and the second line is a rather broad brownish fuscous suffusion; an interrupted terminal slender fuscous line thickened between the veins; cilia brownish, darker towards the base and obscurely barred with paler. A distinct fuscous linear transverse discal dot. Hindwings as forewings; first line absent; fuscous suffusion beyond second line less distinct, except near tornus and about middle; a transverse, slightly elongate fuscous discal dot. Beneath, whitish; first line absent, discal dots as above, second line very distinct and closely followed posteriorly by a broad fuscous suffusion not reaching the hind margin in the hindwings.

Queensland: Toowoomba (January and February, 1 ♂, 1 ♀).

Holotype and allotype in collection Barnard.

14. Genus Crypsiphona.

Meyrick, Proc. Linn. Soc. N.S.W., (2) 2, 1888, 901; Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 630; Prout, *Gen. Insect.*, fasc. 129, 1912, 44; Turner, *Trans. Roy. Soc. S. Aust.*, 45, 1922, 279.

Face smooth. Tongue well developed. Palpi obliquely ascending, basal and second joints with long rough hairs beneath; basal joint longer than second joint; terminal joints short in both sexes. Antennae in ♂ pectinated, apices simple; in ♀ simple. Thorax not crested, or with a slight anterior crest; beneath densely hairy. Abdomen without dorsal crests; in ♂ with lateral tufts of hair on each segment, posterior tibiae without middle spurs in both sexes; in ♂ sometimes dilated, with groove containing hair pencil. Hindwings without basal costal expansion; frenulum and retinaculum well developed in ♂, frenulum in ♀ represented by a tuft of long hairs. Forewings: R_1 anastomosing with Sc and R_2, $R_{2-3-4-5}$ stalked, M_1 separate or short-stalked, M_3 and Cu_{1a} separate. Hindwings: Sc + R_1 closely approximated to cell near base, rapidly diverging; Rs and M_1 separate or connate, M_3 and Cu_{1a} separate. Discocellulars nearly straight; rather strongly oblique, costal edge of cell considerably exceeding two-thirds. Type, *C. occultaria* Don.

Key to Species.

1. Face black ..... *occultaria*
   Face not black 2
2. Cilia brown barred with white between veins ..... *eremnopis*
   Cilia not so 3
3. Forewings with black markings ..... *melanosema*
   Forewings without black markings ..... *amaura*

44. Crypsiphona melanosema. Pl. xvi, fig. 16.

Meyrick, Proc. Linn. Soc. N.S.W., (2) 2, 1888, 901; Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 631; Prout, *Gen. Insect.*, fasc. 129, 1912, 44; Turner, *Trans. Roy. Soc. S. Aust.*, 46, 1922, 279.

Western Australia: Albany (September to December), Denmark (April).

45. Crypsiphona amaura. Pl. xvi, fig. 15.

Meyrick, Proc. Linn. Soc. N.S.W., (2) 2, 1888, 902; Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 631; Prout, *Gen. Insect.*, fasc. 129, 1912, 45.

Western Australia: Albany (September, October, February and April), Busselton (February and October).

46. Crypsiphona occultaria.

Phalaena occultaria, Donovan, *Ins. New Holland*, 1805, t. 36, f.****.—*Boarmia ocultaria*, Boisduval, *Faune Ent. Pacif.*, 1, 1832, 257.—*Hypochroma occultaria*, Guenée, *Spec. Gen. Lep.*, 9, 1858, 281.—*Crypsiphona occultaria*, Meyrick, Proc. Linn. Soc. N.S.W., (2) 2, 1888, 903; Turner, Proc. Linn. Soc. N.S.W., 35, 1910, 631; Prout, *Gen. Insect.*, fasc. 129, 1912, 44.

Northern Australia: Darwin; Queensland: Townsville, Stannary Hills, Duaringa, Yeppoon, Gayndah, Nambour, Nanango, Brisbane, Mt. Tambourine, Bunya Mts., Dalby, Toowoomba, Stanthorpe, Warwick, Charleville; N. S. Wales: Lismore, Port Macquarie, Newcastle, Sydney, Blue Mts., Mittagong, Bathurst; Victoria: Birchip, Melbourne, Beaconsfield, Gisborne; Tasmania: Hobart, Tasman Pen., Cygnet, Launceston, Wilmot; South Australia: Mt. Lofty; Western Australia: Albany, Waroona.

47. Crypsiphona eremnopis. Pl. xvi, fig. 17.

Turner, *Trans. Roy. Soc. S. Aust.*, 46, 1922, 279.

Western Aust.: Cunderdin (October), Mt. Barker.

This species bears a close resemblance to species of the Genus *Paraterpna*, but in the forewing R_1 anastomoses only with Sc, and in the hindwing Rs and M_1 are connate and not stalked. The thorax of the type is abraded and the presence or absence of crests cannot be determined.

Index to Genera (synonyms in *italics*).

Absala, 8; Aeolochroma, 9; *Archeopseustes*, 8; Austroterpna, 6; *Autanepsia*, 11; *Calleremites*, 8; Crypsiphona, 14; Cyneoterpna, 11; Epipristis, 13; *Euarestes*, 10; Heliomystis, 2; Hypobapta, 5; *Hypochroma*, 8; Oenochlora, 10; *Pachyodes*, 8; Paraterpna, 12; Pingasa, 7; Protophyta, 1; *Pseudoterpna*, 8; *Psilostagma*, 8; Rhuma, 3; *Skorpisthes*, 7; Sterictopsis, 4; Terpna, 8.

Index to species (synonyms in *italics*).

acanthina, 30; *acutangula*, 16; alpina, 40; amaura, 45; argyraspis, 4; *assidens*, 18; atriscripta, 15; *aurantiacea*, 18; australis, 43; barnardi, 8; blanda, 16; *bryophanes*, 28; bryophylla, 21; calliglauca, 24; castanea, 1; *cetraria*, 20; chlora, 14; cinerea, 17; *communicans*, 13; *commutata*, 13; conspurcata, 25; *decristata*, 13; deteriorata, 23; diffundens, 10; divergens, 5; electrica, 2; emiliaria, 18; erebata, 26; erebusata, 26; eremnopis, 47; eugramma, 7; *grandidieri*, 13; harrisoni, 41; *horridata*, 23; hypochromaria, 28; idiographa, 11; imperialis, 38; *inconsequens*, 4; melaleucae, 36; melanosema, 44; metarhodata, 34; minimaria, 42; mniaria, 32; multicolor, 19; *munita*, 15; *myriosticta*, 25; muscosaria, 20; *nigraria*, 23; *nobilitans*, 38; *nyctemerata*, 13; occultaria, 46; *ochrea*, 35; *oxycyma*, 42; paratorna, 12; *paratorna*, 4; paroptila, 22; *parvula*, 42; *patrocinatus*, 38; percomptaria, 6; *perfectaria*, 13; *perfulvata*, 31; *purpurifera*, 18; *purpurissata*, 18; quadrilinea, 35; rhodochlora, 33; ruginaria, 13; saturataria, 31; *singularis*, 17; *squamata*, 20; subaurata, 3; *subornata*, 18; subrubescens, 29; *truncataria*, 42; turneri, 37; *undascripta*, 17; unitaria, 30; viridicata, 27; wilsoni, 39; xenomorpha, 9.

The following notes on Australian species are outside the scope of the present paper as set out in the introduction, but the opportunity is taken of recording species new to the Australian Fauna, and notes on other species of the family.

Genus Xenochlaena.

Lower, *Trans. Roy. Soc. S. Aust.*, 27, 1903, 192.

Face smooth, frons projecting somewhat. Palpi 2, second joint two-thirds, terminal joint one-third. Antennae bipectinate to about four-fifths, apex simple.

Thorax and abdomen smooth. Thorax hairy beneath. Posterior tibiae with median spurs absent. Fovea absent. Hindwings without rounded basal costal expansion at base. Frenulum and retinaculum well developed in ♂, in ♀ unknown. Forewing: R_1 from cell and free, approximated to Sc, $R_{2-3-4-5}$ stalked from angle of cell, M_1 short stalked, M_2 from above middle of discocellulars, M_3 and Cu_{1a} separate. Dorsal edge of cell much longer than costal edge, discocellulars strongly curved inwards. Hindwing: Sc + R_1 approximated to cell near base only, gradually diverging, Rs and M_1 long stalked from angle, M_2 from above middle, M_3 and Cu_{1a} separate, discocellulars hardly curved.

It seemed desirable to diagnose the genus afresh.

Xenochlaena porphyropa.

Arrhodia porphyropa, Lower, Proc. Linn. Soc. N.S.W., 23, 1898, 42.—*Xenochlaena porphyropa*, Lower, *Trans. Roy. Soc. S. Aust.*, 27, 1903, 192.

One ♂, through the generosity of the South Australian Museum, where there are other specimens.

Genus Alloeopage.

Prout, *Novit. Zool.*, 20, 1913, 404.

The genus seems sufficiently distinct from *Helicopage* Warren, in that veins R_1 and R_2 of the forewing are long stalked from the cell, whereas in the latter genus they are separate. In *Alloeopage* the retinaculum appears to be normal.

Type of genus, *A. cinerea* Warren.

Alloeopage cinerea. Pl. xvi, figs. 2, 3.

Agathia cinerea, Warren, *Novit. Zool.*, 3, 1896, 284.—*Helicopage velata*, Warren, *Nov. Zool.*, 6, 1899, 330 (nov. syn.).—*H. cinerea*, Prout, *Gen. Insect.*, fasc. 129, 1912, 63.—*Alloeopage cinerea*, Prout, *Nov. Zool.*, 20, 1913, 404.

Q'land: Cape York (May and June, Barnard), Kuranda (January, Dodd).

Genus Hemichloreis.

Turner, *Proc. Roy. Soc. Q'land*, 29, 1917, 71.

Face smooth, tongue well developed. Palpi moderate, porrect, basal and second joints shortly rough-haired beneath, terminal joint in ♂ short, obtuse, in ♀ longer. Antennae in ♂ bipectinate, apices simple, in ♀ minutely ciliated. Thorax not crested, beneath not hairy. Abdomen not crested. Femora not hairy. Posterior tibiae with all spurs present, in ♂ not dilated. Hindwings without rounded basal costal expansion, frenulum and retinaculum in ♂ well developed. Forewings: cell short, about two-fifths, R_1 from cell before angle, running into Sc, $R_{2-3-4-5}$ and M_1 stalked from angle, M_2 remote, M_3 and Cu_{1a} stalked. Hindwing: cell short, about two-fifths, Sc + R_1 approximated to cell near base, then rather rapidly diverging, Rs and M_1 stalked from angle, M_2 remote, M_3 and Cu_{1a} stalked.

The capture of a second ♂ has enabled a more thorough examination of the venation to be made, resulting in some alteration in the generic diagnosis being necessary. Unfortunately in the type ♂ (*theata*) the median spurs of the hind tibiae are broken off one tibia; in the second male they are clearly present.

Type of genus, *H. exoterica* Meyrick (= *theata* Turn.).

Hemichloreis exoterica. Pl. xvi, fig. 12.

Iodis exoterica, Meyrick, Proc. Linn. Soc. N.S.W., (2) 2, 1888, 891.—*Hemichloreis theata*, Turner, *Proc. Roy. Soc. Q'land*, 29, 1917, 71.

Turner's species is the male of *H. exoterica*, Meyrick, the ♀ differing considerably in markings.

N. S. Wales: Taree (December), Newcastle, National Park, near Sydney (February).

AGATHIOPSIS MACULATA. Pl. xvi, fig. 1.

Warren, *Novit. Zool.*, 3, 1896, 286.—*Agathia benedicta*, Pagens, *Zoologica*, 29, 1900, 152, t. 2, f. 39.—*Agathiopsis maculata*, Prout, *Gen. Insect.*, fasc. 129, 1912, 92.

Q'land: Cape York (1 ♂, June, Barnard).

Not hitherto recorded from Australia.

ULIOCNEMIS ELEGANS.

Warren, *Nov. Zool.*, 6, 1899, 28.—*U. cassidara* Pagens., *Zoologica*, 29, 1900, 153 (*nec* Guenée).—*U. elegans*, Prout, *Gen. Insect.*, fasc. 129, 1912, 92.

Q'land: Cape York (April, June, November; A series, Barnard).

Hitherto doubtfully recorded from Australia.

EUCYCLODES FASCINANS Lucas.

Warren (*Novit. Zool.*, 19, 1912, 69) points out that his *dentata* is the ♀ of Lucas's species. I have also arrived at the same conclusion, having taken both sexes flying together in the Cairns district, but not actually *in cop.*

EXPLANATION OF PLATES XIV-XVI.

Plate xiv.

1.—*Terpna mniaria* Goldfinch. ♂.
2.—*Terpna mniaria* Goldfinch. ♂. Underside.
3.—*Terpna saturataria* Walker. ♂
4.—*Terpna saturataria* Walker. ♂. Underside.
5.—*Terpna hypochromaria* Guenée. ♂.
6.—*Terpna hypochromaria* Guenée. ♂. Underside.
7, 8.—*Protophyta castanea* Lower. ♂.
9, 10.—*Protophyta castanea* Lower. ♀.
11.—*Heliomystis electrica* Meyrick. ♂.
12.—*Terpna viridicata* Lucas. ♀.
13.—*Pingasa bryophylla* Goldfinch. ♂.
14.—*Pingasa muscosaria* Guenée. ♂.
15.—*Pingasa calliglauca* Turner. ♂.
16.—*Pingasa deteriorata* Walker. ♂.
17.—*Pingasa conspurcata* Lucas. ♀.
18.—*Pingasa unitaria* Walker. ♂.

Plate xv.

1.—*Pingasa atriscripta* Warren. ♂.
2.—*Pingasa blanda* Pagenstecker. ♀.
3.—*Pingasa cinerea* Warren. ♂.
4.—*Sterictopsis divergens* Goldfinch. ♂.
5.—*Sterictopsis argyraspis* Lower. ♂. Melanic form.
6.—*Sterictopsis argyraspis* Lower. ♀. Normal form.
7.—*Terpna metarhodata* Walker. ♂.
8.—*Pingasa ruginaria* Guenée. ♂.
9.—*Pingasa chlora* Cramer. ♂.
10.—*Cyneoterpna wilsoni* Felder. ♂.
11.—*Paraterpna harrisoni* Goldfinch. ♂.
12.—*Cyneoterpna alpina* Goldfinch. ♂.
13.—*Terpna quadrilinea* Lucas. ♂.

14.—*Terpna melaleucae* Goldfinch. ♂.
15.—*Hypobapta barnardi* Goldfinch. ♂.
16.—*Hypobapta eugramma* Lower. ♂.
17.—*Terpna subrubescens* Warren. ♂.
18.—*Terpna subrubescens* Warren. ♀.
19.—*Terpna unitaria* Walker. ♂. Underside.

Plate xvi.

1.—*Agathiopsis maculata* Warren. ♂.
2.—*Alloeopage cinerea* Warren. ♀.
3.—*Alloeopage cinerea* Warren. ♂.
4.—*Pingasa bryophylla* Goldfinch. ♂. Underside.
5.—*Pingasa muscosaria* Guenée. ♂. Underside.
6.—*Pingasa deteriorata* Walker. ♂. Underside.
7.—*Pingasa paroptila* Turner. ♂.
8.—*Terpna unitaria* Walker. ♂.
9.—*Aeolochroma turneri* Lucas. ♂.
10.—*Aeolochroma turneri* Lucas. ♀.
11.—*Pingasa erebata* Walker. ♂.
12.—*Hemichloreis exoterica* Meyrick. ♂.
13.—*Epipristis australis* Goldfinch. ♀.
14.—*Epipristis minimaria* Guenée. ♂.
15.—*Crypsiphona amaura* Meyrick. ♂.
16.—*Crypsiphona melanosema* Meyrick. ♂.
17.—*Crypsiphona eremnopis* Turner. ♂.
18.—*Terpna rhodochlora* Goldfinch. ♀.
19.—*Austroterpna idiographa* Goldfinch. ♂.

NOTES ON AUSTRALIAN DIPTERA. XXI.

By J. R. Malloch.

(*Communicated by I. M. Mackerras.*)

(Seven Text-figures.)

[Read 25th September, 1929.]

Family Asilidae.

Genus Ommatius Wiedemann.

I have carefully examined all the Australian material available to me in the United States National Museum, kindly placed at my service by Dr. Aldrich of that institution, and identify as amongst this the following four species generally placed in *Ommatius*.

Ommatius chinensis (Fabricius).

In a recently published paper (*Proc. Roy. Soc. Qsld.*, xl, 1928, 61) Mr. G. H. Hardy has figured the hypopygia of eight Australian species, including that of *chinensis*. He questions the identity of the Australian species with the one occurring in Asia, and under his figures credits the species to Ricardo. The Australian specimens I have seen agree absolutely in every detail with undoubted examples of *chinensis* from Japan in the collection of the United States National Museum.

Mr. Hardy's figure of the hypopygium of *chinensis* is incorrect, the portion lettered as the upper forceps being merely a slightly raised section margined by a slightly depressed striate line of demarcation, and both his "*u.f.*" and "*l.f.*" constitute the upper forceps (ninth tergite). I figure the hypopygium of an Australian male (Text-fig. 1) showing the various portions from the side as in Hardy's published figures.

As additional characters distinguishing this species from the genotype of *Ommatius*, and from the Australian species of the genus, one may list the much wider vertex, upon the sides of which the hairs extend to anterior margin instead of being confined to posterior margin, the broader and more uniformly haired face, the short, preapically sulcate, scutellum, and the fusion on the subcostal cell with costa at a point almost above the cross-vein instead of distinctly before it. As I have already pointed out in a previous paper, I do not consider this species belongs to *Ommatius*, but I am unable to determine if it is an *Allocotosia* for lack of an opportunity to examine the genotype of the latter.

Locality.—Cairns, N. Queensland.

Ommatius distinctus Ricardo.

In the male sex this species is readily distinguished from the other species by the presence of a conspicuous blackish spot at apex of the costa of wing. The female is not so readily distinguished because the wings are almost or quite

clear. There is a character in the bristling of the mid femur which appears to be reliable for distinguishing both sexes from the other two small species now before me. This character consists of the arrangement and number of bristles on the anterior side of the femur. In *distinctus* all the bristles are confined to the anteroventral surface beyond the middle, but in the other two there is one bristle on either the anterior or anterodorsal surface about in vertical line with the one on anteroventral surface nearest to the apex of femur. I have figured the femora of the three species to illustrate better what is intended (Text-figs. 2, 3, 4). In all three species there is a single bristle on the anterior side about one-fourth from the base and also three anteroventral bristles, the one nearest apex being slightly higher placed than the others. The distinction in the three species lies in the presence or absence of an additional bristle above the one nearest apex, and, when present, in its position. In *distinctus* this additional bristle is lacking (Text-fig. 2), while in the other two species it is present. This character holds throughout the material I have in both sexes, but, owing to the fact that the leg bristles in this family are notoriously variable both in number and in colour, it would be too much to expect that it will hold invariably in all specimens of this or the other two species. These strong bristles are black and readily distinguishable in *distinctus* and *queenslandi*, but usually they are pale in *flavicaudus*. Ventral plate as in Text-figure 5.

Localities.—Cairns and Gordonvale, N. Queensland (E. Jarvis; J. F. Illingworth).

Ommatius queenslandi Ricardo.

Rather darker in colour than *distinctus*, with the costa of wing very slightly incrassated and in some specimens with a very faint indication of a dark apical spot.

Hardy's figure of the hypopygium is rather diagrammatic to give a proper conception of its structure, so I present figures of it and the ventral plate (Text-figs. 6, 6*a*). The latter is glossy black, furnished with long yellow hairs, and at bases of these there is a dense fringe of short pale hairs.

I have seen only males of this species, and in these the entire facial bristling is yellowish-white and extends over three-fourths of the distance from lower margin to bases of antennae. The facial bristles in *distinctus* are mixed black and white and they do not extend over two-thirds of the distance to bases of antennae.

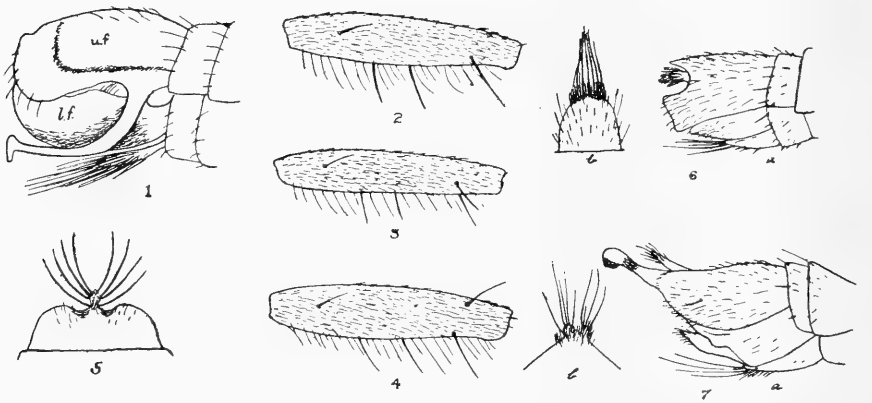
Localities.—Cairns and Gordonvale, N. Queensland (E. Jarvis).

Ommatius flavicaudus, n. sp.

This is evidently the species accepted as *dimidiatus* Macquart by Hardy, and possibly also by White. In all the specimens of both sexes now before me, the apex of the abdomen is quite conspicuously testaceous yellow, and it would appear remarkable that Macquart, who usually noted colour characters very closely, should have overlooked this feature if he had the present species before him when he described *dimidiatus*.

White claims for the New South Wales examples that he had, only that they agreed "fairly well" with Macquart's description, and I am of the same opinion as Hardy, that he probably had two species mixed in his series. I do not know the basis for the latter's statement that the locality Tasmania for *dimidiatus* is erroneous, as the type specimen is lost or destroyed and neither its source of origin nor identity can be determined authentically now.

Male and female.—Fuscous, densely grey dusted, at least the apical tergite and hypopygium in the male, and the apical tergite in female, testaceous yellow. Frons black, dark brown dusted in front, face yellowish-grey dusted, frontal hairs black, all the hairs and the bristles on face and occiput whitish-yellow; antennae black. Mesonotum with three broad, fused partial, subshining, fuscous vittae, the hairs and bristles except the lower notopleural bristle yellowish-white. Abdomen with the hairs and bristles, except a few at apex, yellowish-white. Wings hyaline, with a faint dark shade at apex. Legs reddish-yellow, with the following black markings: front femora except below, anterior surface of mid femora, a preapical ring on each hind femur, sometimes broken below, the apices of all tarsal segments, the latter progressively more broadly black from basal to apical segment; most of the femoral and tibial bristles whitish or yellowish, those of the tarsi mostly black.



Text-fig. 1.—*Ommatius chinensis*. Hypopygium from the side.
Text-fig. 2.—*Ommatius distinctus*. Mid femur from in front.
Text-fig. 3.—*Ommatius flavicaudus*. Mid femur from in front.
Text-fig. 4.—*Ommatius queenslandi*. Mid femur from in front.
Text-fig. 5.—*Ommatius distinctus*. Ventral plate.
Text-fig. 6.—*Ommatius queenslandi*. *a*, hypopygium from the side; *b*, ventral plate.
Text-fig. 7.—*Ommatius flavicaudus*. *a*, hypopygium from the side; *b*, ventral plate.

Bristles of face extending over two-thirds of the distance from lower margin to bases of antennae. Scutellum with two strong apical bristles which are divergent and slightly forwardly sloped. Hypopygium as in Text-figure 7. Mid femur with the anterior bristles as in Text-figure 3; hind femur with anteroventral and posteroventral bristles in both sexes. Costal vein quite noticeably swollen beyond apex of subcostal vein, but not noticeably explanate, in male, costal vein in female hardly swollen.

Length, 9-10·5 mm.

Type, male, allotype, one male and one female paratypes, Cairns, N. Queensland (J. F. Illingworth); two male paratypes, Gordonvale, N. Queensland (E. Jarvis). United States National Museum.

The entirely pale facial hairs and bristles would appear to be an additional character for considering this species as distinct from *dimidiatus*, and the markings of the legs could by no means be construed to fit Macquart's description.

THE LIFE HISTORY OF *DORYANTHES EXCELSA*.

PART II. THE GAMETOPHYTES, SEED PRODUCTION, CHROMOSOME NUMBER AND GENERAL CONCLUSION.

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(*From the Botanical Laboratories, University of Sydney.*)

(Plates xvii-xix; and twenty-six Text-figures.)

[Read 28th August, 1929.]

Contents.

Introduction.
Development of the Gametophytes, male and female.
Pollination and Fertilization.
The Seed.
Chromosome Number.
Chronology and Synchronology.
Conclusion.
Summary.

Introduction.

This paper concludes the investigation of the Life History of *Doryanthes excelsa*. Except for the composition and a few drawings, the work for this paper was done as a Science Research Scholar of the University of Sydney. Part 1 of this inquiry (Newman, 1928) described the vegetative body, and the reproductive processes up to the formation of the spores. The present communication describes the germination of the spores and the subsequent developments culminating in the organization of the seed. The conclusion will be concerned with both parts of the inquiry. The bibliography, except in a few cases, deals only with the Amaryllidaceae and nearly related families.

DEVELOPMENT OF THE GAMETOPHYTE.

Description.

MALE.

Germination of the Spore.

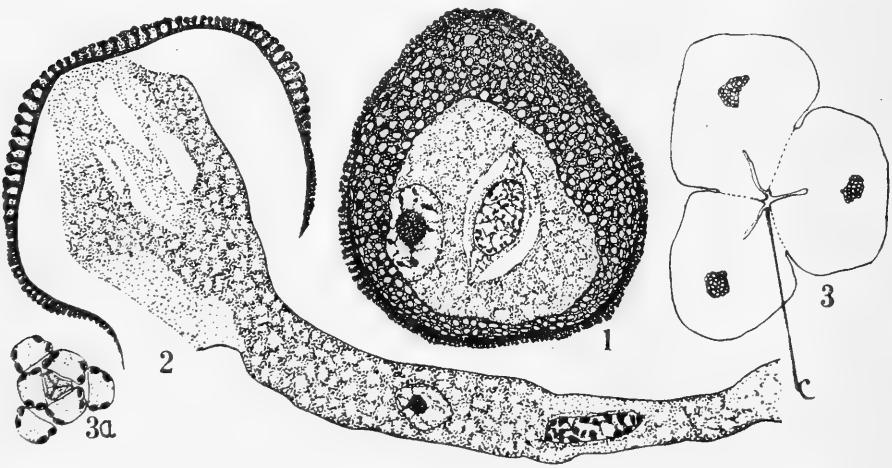
The newly formed microspore has very dense non-vacuolate cytoplasm (Text-figure 37 in Part 1 of this inquiry—Newman, 1928). The first sign of germination is the marked vacuolation which generally displaces the nucleus away from the pore and continues till the nucleus has divided (Plate xvii, figs. 1-9). After this, the cytoplasm becomes extremely dense as the time for shedding the pollen approaches (Plate xvii, figs. 10, 11, and Text-fig. 1). An interesting feature during this division is the presence of dark bodies in the cytoplasm. Appearing before the prophase begins, they persist till the telophase, with decreasing definition

(Plate xvii, figs. 1, 2, 5, 6, 9). A detailed study was not made; but attention can be called to the following points. There may be as many as four, and they are usually near to, or in contact with, the nucleus, appearing to be associated with the process of division, though not with spindle formation. Sometimes they seem to be in pairs or in process of fission. One or two clear spots are to be seen in them, and at times there is the appearance of a distinct boundary line. The stain was Haidenhain's iron alum haematoxylin, so that the Wratten F filter used in making the photomicrographs for the figures gives the bodies a denser appearance than in reality.

As far as studied, the mitotic figure appears normal, with its broad, slightly convergent spindle which fans out to meet the spore wall during the deposition of the new wall; and the short stout chromosomes which move apart in regular formation (Plate xvii, figs. 4-9 and Text-figs. 21 and 22). The wall, laid down as a curved chord of the circle of the intine, shuts off the small generative cell from the rest of the spore (tube cell). Even at this early stage the generative nucleus is much smaller than the tube nucleus (Plate xvii, fig. 10).

Mature Pollen Grain.

The mature pollen grain has dense cytoplasm which takes a variety of stains very deeply (Plate xviii, fig. 23 and Text-fig. 1). Pollen grains on the stigma show, in section, the characteristic lenticular generative cell whose nucleus has granular chromatin, and no nucleolus; whereas the tube nucleus has a prominent nucleolus and inconspicuous chromatin (Text-fig. 1). In comparison with Plate xvii, figs.



Text-fig. 1.—Section of a pollen grain on a stigma. The upper surface of the section has passed well away from the centre of the grain. The wall of the grain is shown in transverse section at the edge, elsewhere in surface view. The tube nucleus and generative cell are embedded in dense cytoplasm. The section has not passed through the pore. × 1025.

Text-fig. 2.—Germinating pollen grain. The generative cell, preparing for division, is preceding the tube nucleus into the tube. × 1025.

Text-fig. 3.—Transverse section of the style. The three long rays of the canal (*c*) are the spaces between the incurved halves of the sporophylls. × 12.

Text-fig. 3*a*.—Diagrammatic transverse section of the anthers and stigma in an unexpanded flower. The backs of the three inner anthers effectually close in the small triangular stigma.

10 and 11, the nuclei are seen now to be more of a size. The exine is reticulately thickened to a considerable depth (Text-figs. 1 and 2 and Plate xvii, figs. 7, 8 and 11), except at the place of the single pore (Plate xvii, figs. 6, 7, 8, 10, 11). Oil drops occur on the exine of the grains at the time of dehiscence.

Pollen Tube and Contents.

As with the mature pollen, the examination of the contents of the pollen tube was hindered by the dense cytoplasm's tenacity of stains, for by the time the cytoplasm had been destained sufficiently to permit of the nuclei being seen clearly, the nuclei were almost completely destained. Text-fig. 2 is from a permanent preparation and shows two nuclei in the tube, the front one, by comparison with Text-fig. 1, appearing to be the generative nucleus surrounded by a thin layer of its own cytoplasm. On the other hand, in a living tube taken from the cup of the flower, there appeared to be the tube nucleus at the tip and two male nuclei behind. Nothing further has been observed concerning these nuclei, despite a long and careful search.

As the protoplasm of the tube passes forward, the empty upper parts are repeatedly shut off by plugs across the lumen of the tube (Plate xvii, fig. 14, and Plate xviii, fig. 24). With care, it is possible to get a differential staining between the tube and the plugs; so that with orange G and gentian violet, gold plugs in violet tubes can be obtained. In staining reactions the plugs appear to be cellulosic and not much different from the tube walls, but, from their often irregular shape, pitted appearance and differential staining, it could be inferred that they also contain some waste material. The ability to take a differential stain is in some measure due to the difference in thickness between them and the walls (*see* Plate xviii, fig. 24).

FEMALE.

Germination of the Spore.

Apart from increase in its size, the first sign of the germination of the megaspore is the formation of large vacuoles in the originally dense cytoplasm, so that Text-fig. 43 in Part 1 of this inquiry (Newman, 1928) is not the functional megaspore, as stated, but the uni-nucleate stage of the embryo sac. The first division of the nucleus therefore takes place in a highly vacuolate cytoplasm (Text-fig. 4). After this division is completed, the vacuolation takes the characteristic form of a large central vacuole between the two nuclei (Text-fig. 5). The polarity thus acquired is maintained during the rest of the history of the sac.

Development of the Embryo Sac.

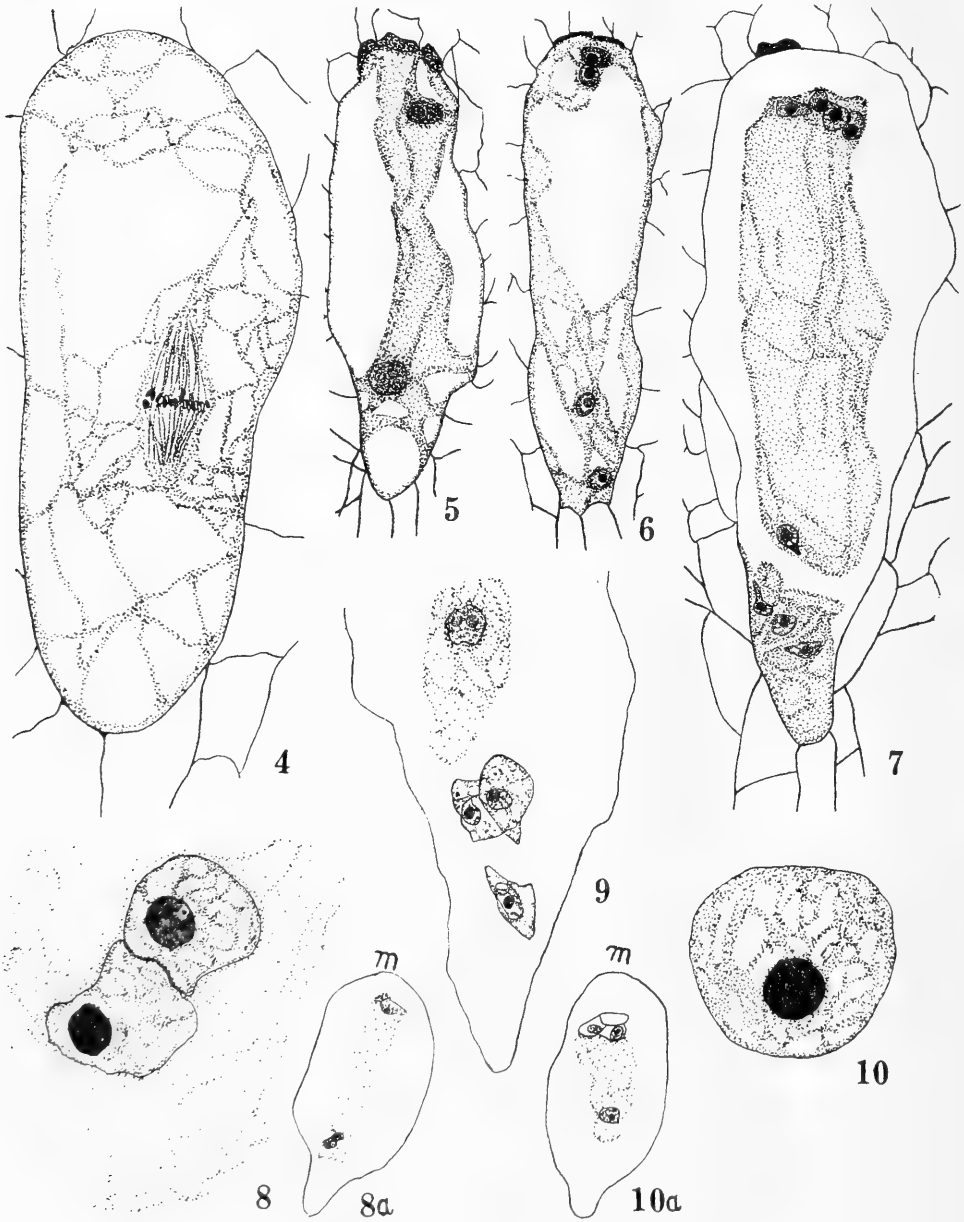
Growth.

Though the general dimensions of the mature sac are about eight times those of the megaspore, the antipodal quarter of the sac at the time of the first division scarcely grows at all, owing to the thickening of the walls in that region (compare Text-fig. 4 with Plate xvii, fig. 12), the result being a very pronounced antipodal pocket at the base of the projectile-shaped mature sac.

Contents.

There is nothing unusual about the three nuclear divisions in this embryo sac, the greater interest lying in the behaviour of the cytoplasm as it affects the distribution and function of the nuclei. The large vacuole formed after the first

division occupies only two-thirds or three-fourths of the length of the sac, the lower portion of the sac being filled with cytoplasm having several lesser vacuoles. This lower part of the sac will become the antipodal pocket. At the four-nucleate stage the two micropylar nuclei are close together in the thin peripheral layer of



cytoplasm; and the chalazal nuclei are distinctly spaced vertically in the copious cytoplasm of that region (Text-fig. 6). In the third division there appears an aggregation of cytoplasm around the dividing micropylar nuclei (Plate xvii, fig. 15), though not distinctly shown in Text-fig. 7 of the completed division. In this division, there are slight aggregations around the antipodal nuclei. These aggregations foreshadow the formation of cells. About the time of this division, a break in the cytoplasm occurs near the top of the antipodal pocket, cutting off one of the four chalazal nuclei and leaving the three antipodal nuclei in the pocket (Text-fig. 7). The sac has now two cytoplasmic masses, the lower of which disappears after the antipodals, which it surrounds, are organized as cells (Text-figs. 7, 9, 12).

Differentiation of the Elements of the Sac.

Egg Apparatus.

The upper cytoplasmic mass contains five nuclei, one being at its base. Of the four nuclei at the micropylar end, one migrates to the base, leaving three nuclei to be formed into a typical egg apparatus by the gathering of cytoplasm and the deposition of walls round them (Plate xvii, figs. 12 and 13). The relationship of the three nuclei to one another and to the polar nucleus that migrates is indicated by the disposition of the nuclei from the four- to the eight-nucleate stage.

Text-figure 6 shows the two micropylar nuclei standing in vertical relationship; in Plate xvii, figure 15, one division is vertical and the other horizontal; and in Text-figure 7 the nuclei are in two pairs at slightly different levels. The inference is that the migrating polar nucleus is the lower product of the vertical division of the lower micropylar nucleus of Text-figure 6. Therefore, the most natural source of the egg nucleus would be the upper product of that division, leaving the synergid nuclei as sisters.

The synergids are characteristically pyriform, with striations on the beaks (filiform apparatus). The cytoplasm is dense in the upper part and highly vacuolate at the base, the very prominent nucleus being situated at the join of the zones of cytoplasm. The filiform apparatus stains as the walls, taking light green and gentian violet, in strong contrast to orange G or safranin in the cytoplasm. Except where torn away in the preparation, the synergids are closely pressed against the wall of the embryo sac (Plate xvii, fig. 12, and Plate xviii,

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Text-figs. 4-10*a*.—The germination of the megaspore to the eight-nucleate embryo sac, and the fusion of the polar nuclei. Longitudinal sections of the sac. The crushed non-functional spores are to be seen at the top of the sac.

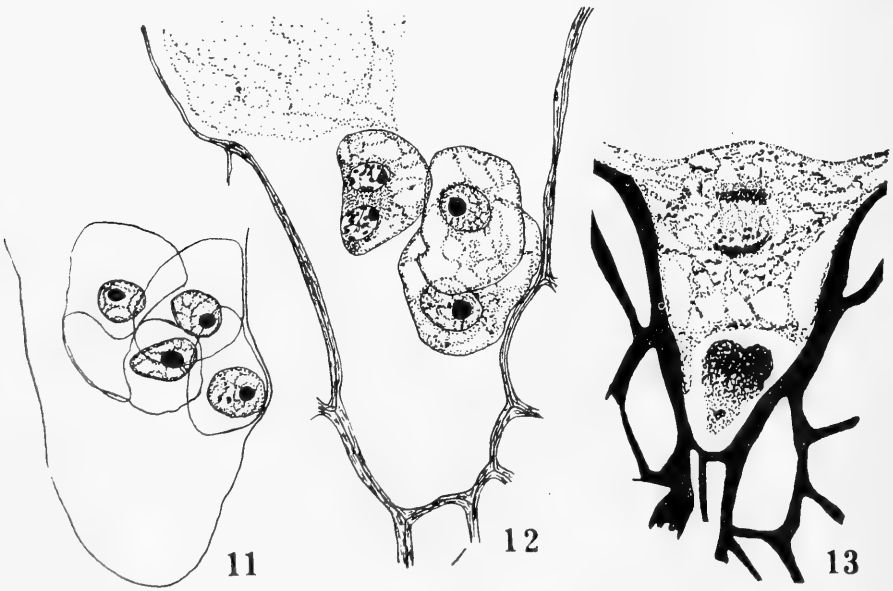
4.—Metaphase spindle of the first division, in a largely vacuolate cytoplasm; 21 chromosome pairs, unseparated, can be seen. × 1132. 5.—Two-nucleate sac; as the large central vacuole has been plasmolyzed, there appears to be a central strand of cytoplasm. × 380. 6.—Four-nucleate sac, the chalazal nuclei in vertical relationship; central vacuole. × 377. 7.—Eight-nucleate sac; between the two groups of nuclei the large central vacuole has plasmolyzed (*cf.* fig. 5); a break in the cytoplasm at the top of the antipodal pocket has cut off the chalazal polar nucleus from the antipodal nuclei; there are slight aggregations of cytoplasm to the antipodal and micropylar nuclei. × 386. 8-10*a*.—Stages in the fusion of the polar nuclei; 8*a* and 10*a* show the position in the sac of the nuclei in Figs. 8 and 10 respectively, *m*, the micropylar end. 8, × 1257; 9, × 392; 10, × 1270; 8*a* and 10*a*, × 118. Fig. 9 also shows the antipodals as three cells, the lower mass of cytoplasm having disappeared after the formation of these cells. × 392.

fig. 16). Right up to the time of fertilization the synergid nuclei appear very prominent and active, almost more so than the egg nucleus.

Though at first having a uniform distribution of cytoplasm, the egg immediately before fertilization has only a peripheral layer of cytoplasm, with or without a central strand leading vertically from the nucleus which lies at the bottom of the cell (Plate xviii, figs. 17 and 18). At this stage the nucleus, with well defined nucleolus and a loose chromatin network having well-marked basichromatin lumps, is much smaller than the synergid nuclei (Plate xvii, fig. 12, and Plate xviii, figs. 16-18).

Fusion of the Polar Nuclei.

The origin of the micropylar polar nucleus as sister to the egg has already been suggested, and the part played by the cytoplasm in determining the chalazal one has been described. In general it seems that fusion begins towards, if not at, the chalazal end of the upper cytoplasmic mass (Text-figs. 8*a*, 9, 10*a*). Cases of uncompleted fusion have been found near the egg apparatus (Plate xviii, fig. 19), though fusion mostly is completed before the fusion nucleus migrates there prior to fertilization; the fusion nuclei seen there are always more advanced towards division. Plate xviii, figure 20, shows such a nucleus which, in this case, is in contact with the egg. The polar nuclei fuse in a reticulate condition, the nucleoli also fusing (Text-figs. 8, 9, 10).



Text-fig. 11.—Antipodal pocket of embryo sac, showing four antipodal cells. × 886.

Text-fig. 12.—Antipodal pocket of embryo sac, showing three antipodal cells, one of which is in process of division. × 886.

Text-fig. 13.—Antipodal end of embryo sac, showing the endosperm nucleus at late anaphase of the first division; a disintegrating antipodal is present; notice the very thick walls round the pocket. × 535.

Antipodals.

Beginning with the aggregation of cytoplasm soon after the third division in the sac, the organization of the antipodals as definite cells with walls is completed before the egg apparatus is matured or polar fusion completed (Text-fig. 9). Their origin has already been described. The number of antipodals is usually three (Plate xviii, fig. 22, and Text-fig. 9). Multiplication sometimes occurs, and as many as five cells have been seen (four are shown in Text-fig. 11 and one out of three dividing in Text-fig. 12). Despite this small multiplication and their persistence till the early division of the endosperm (Plate xviii, fig. 22, and Text-fig. 13), they are insignificant always, and appear to play no part in the nutrition of the sac, being finally crushed by the growth of the endosperm (Plate xvii, fig. 12, Plate xviii, figs. 21, 22, 29 and Text-fig. 13).

Discussion.

General.

In the description of the embryo sac just given, Rutgers' (1923, p. 21) system has been adopted whereby the criterion of the beginning of megaspore germination is the marked vacuolation of the cytoplasm. An attempt has been made, not without success, to determine the germination of the microspore of *Doryanthes excelsa* by a similar criterion. By beginning at spore development (pollen and embryo sac development), this part of the inquiry overlaps the last stage of spore formation as it was given in Part 1 of this paper (Newman, 1928). The general course of the germination of the spores appears to be normal. Throughout this discussion the effect of the cytoplasmic behaviour upon polarity in pollen and embryo sac development will be given special attention.

Germination of the spores.

Though megaspore formation lags slightly behind microspore formation, their germination occurs at about the same time. In both, this vacuolation—the ultimate formation of one or two large vacuoles—determines the function of the two products (or their descendants) of the first division. The central vacuole in the embryo sac determines the micropylar and chalazal groups; the vacuoles in the microspore determine the nuclei of the tube and generative cells. For the sake of simplicity, this section only discusses the first division in both spores.

An examination of several textbooks and research papers for figures of germinating microspores was made in order to see if the vacuolation recorded here was usual, but in no case were the figures such as to show the presence or absence of such a phenomenon. A similar statement applies to the dark cytoplasmic bodies in the microspores, whose nearest resemblance is to central bodies. Wilson (1925, pp. 29, 387, 388) says that central bodies are absent in the higher plants except in connection with gametogenesis in some Pteridophytes and Gymnosperms. In *D. excelsa* the bodies were only seen in the division of the spore nucleus, the division of the generative cell not being observed. Sharp (1914, pp. 422-4) in *Marsilia* and Allen (1917, p. 269) in *Polytrichum* record central bodies in pre-gamete-forming divisions. Wilson records central bodies in pre-gamete-forming divisions of *Marsilia* described by Shaw (1898) and Belajeff (1899), and of *Marchantia* by Ikeno (1903). Guignard (1891, p. 541) described centrosomes in the pollen development of *Lilium martagon*; but Schürhoff (1926, p. 469) states this to be a mistake, the bodies being extra-nuclear nucleoli, and

quotes several observers in support of his contention. Welsford (1914, p. 266) describes possible vestigial centrosomes in the generative cell of *Lilium auratum*. If the bodies in *D. excelsa* are such nucleoli, they stain with iron alum haematoxylin much less intensely than does the intra-nucleolar nucleolus.

The exact nature of these bodies in *D. excelsa* is yet undetermined. If they are central bodies, then it is a very primitive and important feature. The marked difference in size between the generative and tube nuclei when just formed is in contrast with the equality shown by Wefelscheid (1911) for *Magnolia yulan*, and by Welsford (1914, p. 267) for *Lilium auratum* where another contrast is the contiguity of the two nuclei, and the late development of the membrane of the generative cell after the division spindle has disappeared.

MATURE POLLEN AND TUBE.

The loss of vacuolation in the pollen grain after the first division is the result of storage of the material necessary for the production of the pollen tube. The filling of the embryo sac by the endosperm is the physiological analogue. There is no tetrad arrangement of the mature pollen, in contrast to the nearly related *Fourcroya cubensis* (Ernst, 1918) and *F. altissima* (Schlimbach, 1924). It is interesting to note that oil drops also occur on the pollen of a widely different plant of the same locality, the Epacridaceous *Styphelia longifolia* (Brough, 1924, p. 164). The two-celled mature pollen is in accord with the other Amaryllidaceae.

Schürhoff (1926, p. 257) describes the tube nucleus as entering the tube before the generative cell which is in process of forming the spindle. The only case seen in *D. excelsa* had the generative nucleus preparing for division, but the generative cell was in advance, as in *Atamosco texana* (Pace, 1913, p. 377).

THE EMBRYO SAC.

The normal eight-nucleate sac of *D. excelsa* follows out the vacuolation and nuclear arrangement described by Rutgers (1923). Schürhoff (1926, pp. 274, 484) divides the Amaryllidaceae into three groups with two, one and no integuments, the first group, except *Cooperia Drummondii*, having normal development of four megaspores, while the other groups have the *Lilium* type of embryo sac formation. To the exception should be added *Cyrtanthus parviflorus* (Stiffler, 1925, p. 212) which also has the *Lilium* type of embryo-sac formation. The Amaryllidaceous sac is eight-nucleate (Schürhoff, 1926, 484) as in this case. *D. excelsa* possesses an insignificant antipodal pocket in common with *Typha*, *Potamogeton*, *Sagittaria*, certain Gramineae, *Pontederia*, *Lilium*, etc. (Coulter and Chamberlain, 1903, p. 104) and *Fourcroya* (*Furcraea*) *andina* (Nevins, 1927, p. 373). This feature is associated with antipodals of the "passive type" of Ikeda (1902) (Coulter and Chamberlain, 1903, p. 111), to which the antipodals of *D. excelsa* belong.

The egg apparatus appears quite normal with the egg-polar and synergid-synergid sisterhood. The similar staining of the filiform apparatus of the synergids and the cell walls is in line with Schürhoff's statement that the former is cellulosic (1926, p. 293). Coulter and Chamberlain (1903, p. 94) associate such synergids as are here with beak-like extensions of the sac and protrusion of both into the micropyle. The latter occurrence requires suppression of the parietal (wall) tissue, an advanced feature suggesting that the filiform apparatus is advanced. The conclusion is supported by the greater prevalence of this association in the Sympetalae than in the Archychlamydeae, though strangely enough it is much

less common in Monocotyledons. Though *D. excelsa* has the filiform apparatus well developed, the thick parietal (wall) tissue—a primitive feature—prevents protrusion into the micropyle.

The fusion of the polar nuclei before fertilization is also found in *Eichornia* (Smith, 1898), *Narcissus* (Guignard, 1900, p. 155) and *Cyrtanthus parviflorus* (Stiffler, 1925, p. 212), in the two latter at the antipodal end, as here. There is, however, some variability in place. In *Cooperia Drummondii* (Church, 1916, p. 400) fusion does not take place till fertilization, when triple fusion can be seen at the antipodal end.

The antipodals, though showing slight occasional multiplication, belong to the "passive" type of Ikeda (1902), a monocotyledonous characteristic according to Coulter and Chamberlain (1903, p. 112). Rutgers (1923, p. 59) says that the increase in the number of antipodal cells indicates an intense nutritive function; so that the antipodals of *D. excelsa*, having both multiplication and insignificance, are in process of losing an intense nutritive function. It is to be noticed that when they do increase it is before fertilization, as in *Avena fatua* (Cannon, 1904), *Zea* and other grasses (Westermaier, 1890, and Guignard, 1901).

Among the Amaryllidaceae, there are the following abnormal antipodals: *Hippeastrum aulicum* (Hofmeister, 1861, p. 677) has only one; in many sacs of the apogamous *Atamosco texana* the antipodals lie next the micropyle, the egg apparatus being lateral (Pace, 1913, p. 381). The following have more or less enlarged antipodals that persist usually for a long time without increase in number: *Haemanthus Catharinae* (Stenar, 1925); *Nerine curvifolia* (Schlimbach, 1924); *N. filifolia*, *N. undulata*, *Vallota purpurea*, *Zephyranthes rosea* (Stenar, 1925); *Cooperia Drummondii* (Church, 1916, p. 400); *Crinum Asiaticum* (Schlimbach, 1924); *Narcissus* sp. (Guignard, 1882). *Ixiolirion montanum* has antipodals which persist for a long time during endosperm formation (Stenar, 1925). Coulter and Chamberlain (1903, p. 102) interpret active antipodals—manifested by the more primitive monocotyledons and the Ranunculaceae—as being a primitive condition; *Doryanthes excelsa* is therefore advanced among the Amaryllidaceae. All the examples in this paragraph are in the Amaryllidoideae section of the family.

POLLINATION AND FERTILIZATION.

Description.

POLLINATING MECHANISM.

The Flower.

There are no special adaptations to wind pollination. The stigma is small and compact; the heavy pollen clings in masses owing to the presence of the oil drops on the grains. Though the pollen sacs begin to burst before the flower opens, no pollen can get on the stigma because the edges of the broad backs of the inner anthers are pressed together, completely shutting off any liberated pollen from the stigma; spreading of the loculus walls more effectively seals it off (Text-fig. 3*a*). The opening of the flower draws the anthers away from the stigma. If self pollination is not actually prevented, there is a beautifully simple mechanism for making it difficult.

The entire stigma is covered with short hairs which are longer at the angles where the clefts, continuous with the stylar canal, open on to the surface. The cleft in the sides does not extend below the stigma. With the aid of the pollen oil, the grains that are brushed from visitors are held very strongly by the

stigma hairs—even in great numbers through the processes of fixing, embedding, cutting and staining.

When the perianth segments are expanded, their whitish-pink inner surface shows up brightly against the generally dark colour of the rest of the flower head, and, with the nectar in the cup, affords adequate attraction for bird and insect visitors.

Agencies.

Bees and flies covered with pollen are found in great numbers on the flower heads. On several occasions the Mutton Bird (*Strepera graculina*) has been seen drinking the nectar. The visitation of such a large bird explains the abundant scarring of the perianth and frequent breaking of style, stamens and perianth. Such visitors as these make cross and self pollination of about equal probability.

THE PATH OF THE POLLEN TUBE.

Except for the part within the ovule, the path of the tube now to be described from fixed material, has been followed in dissections of living material, using the plugs for identification. Plugged tubes have been seen attached to pollen grains; and ovules after dissection from the margin of the carpel have been held suspended by the plugged tube passing into the micropyle.

Germination of the pollen takes place soon after the stigma is exposed; and the tube has reached the micropyle in not more than five days after expansion of the flower. Pollen, when placed in 5% cane sugar solution several days after collection, developed tubes in about three hours.

A flower taken into the laboratory had no pollen on the stigma. Owing to an inversion, a drop of nectar had run on to the stigma, and in this drop was placed pollen from another flower. Twenty-seven hours later the stigma was killed and fixed. Plate xviii, figure 23, shows the extent of germination at this stage, some tubes being among the hairs, and their tips probably well into the stylar canal. The cleft of the stigma is well provided with glandular hairs and together with the stylar canal—an extension of the loculus of the ovary (Text-fig. 3) lined with glandular cells (Plate xviii, fig. 25)—is filled with fluid for the nourishment of the numerous tubes (Plate xviii, fig. 24) which pass down to the cavity of the ovary (Plate xviii, fig. 26), through the micropyles (Plate xviii, fig. 27), across the parietal (wall) tissues and push past the synergids (Plate xviii, fig. 28) to the eggs. The well nourished cells of the inner integument and of the parietal (wall) tissue, and the vigorous synergids all serve to facilitate passage of the tube by providing an abundant food supply.

EVIDENCES FOR FERTILIZATION.

Neither the discharge of the male gametes into the sac nor the process of fertilization has been observed. The indirect evidence is very strong. The pollen tube has been traced as far as the synergids, and a normal embryo is developed in the usual place after the egg nucleus acquires a second nucleolus (Plate xix, fig. 30). That fertilization of some kind occurs is placed beyond doubt by an examination of the chromosomes. Reliable counts of chromosomes in various parts of the vegetative body gave numbers approximating to 44 (Text-figs. 14 and 15). In both microspore and megaspore formation a reduction to 22 chromosomes was observed (Text-figs. 16-20 and 23). The reduced number (22), or very near

it, was counted in several divisions during the germination of both spores (Text-figs. 4, 21, 22, 24). The actual numbers in Text-figs. 4, 14-24 respectively, are: 21 pairs; 44 pairs (approx.); 44 pairs; 4 + 23 + 16 (= 43); 22 and 22 + 2 detached bodies; 22 pairs; 22 pairs; 22 pairs; 19 and 21; 22 and 20; 22. Chromosomes have not been counted in the zygote or embryo, but the above seems conclusive evidence for fertilization.

EVIDENCES FOR TRIPLE FUSION.

The fusion of the second male gamete and the polar fusion nucleus has not been observed. There is, however, strong indirect evidence in support of such an occurrence. The polar fusion nucleus undergoes a marked increase in size (*cf.* Plate xviii, fig. 20, with Plate xix, fig. 34) on acquiring a second nucleolus. The two nucleoli give differential staining reactions with iron alum haematoxylin, cyanin and erythrosin, safranin and gentian violet, safranin and light green; and are later replaced by one larger nucleolus (Plate xix, figs. 34, 35). The nucleus then proceeds to form an endosperm of a known type.

Examination of the chromosomes shows that in the first division of the endosperm nucleus there are 66 chromosomes, representing the triploid condition in a nucleus resulting from the fusion of three of the haploid nuclei described under the section on fertilization (Text-figs. 25 and 26). One other count was made on a nucleus not all included in a section, the number being 54 for that portion of the nucleus. It seems, then, quite conclusive that a normal triple fusion has taken place.

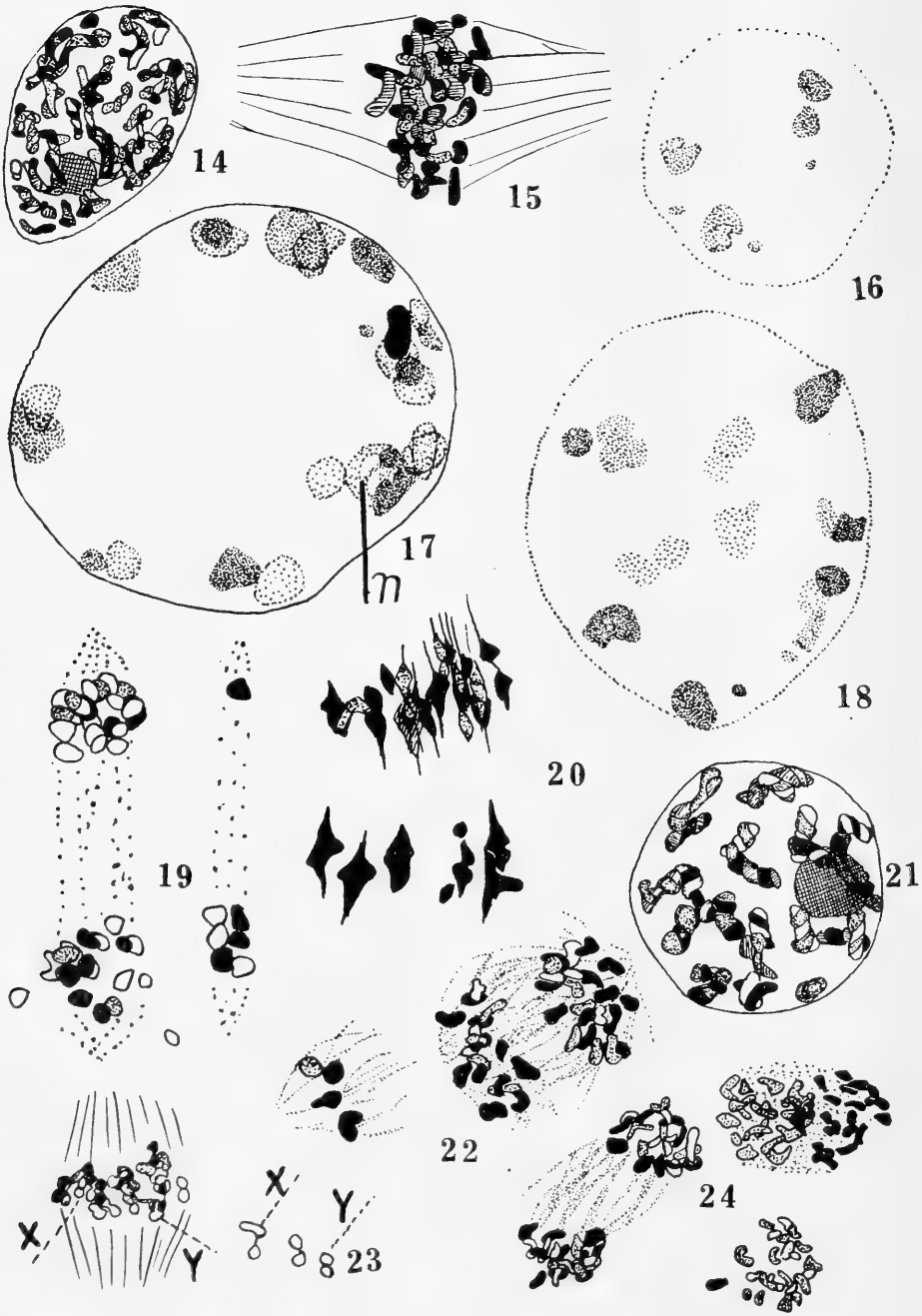
NUCLEAR CONDITION AT TIME OF FUSION.

Just before and after fertilization, the nucleus in the egg has the chromatin as a loose network with prominent basichromatin granules. In this condition it is assumed that fertilization takes place, the nucleolus also being present (Plate xviii, figs. 17, 18, 20; Plate xix, figs. 30, 31). In the case of the triple fusion the polar fusion nucleus has its chromatin in a similar condition though more strongly defined (Plate xvii, fig. 20, and Plate xix, figs. 34-36).

Discussion.

The profuse germination of the pollen of *D. excelsa* is in marked contrast to the sterility of the pollen in the nearly related *Fourcroya altissima* (Schlimbach, 1924). Coulter and Chamberlain (1903, p. 25) point out that what is usually considered "placental" tissue may be really conducting tissue contiguous with the stigmatic surface. But in Part 1 of this inquiry it was shown that the structure usually referred to as "placenta" is, in *D. excelsa*, simply the margin of the sporophyll without specialization in its tissues. The three-rayed stylar canal is the spaces between the opposite sides of the infolded sporophylls. The "conducting tissue" is represented by the epidermis of the sporophylls with a metabolism locally specialized for secretion, and is not continuous with a specialized "placenta" as such.

It is to be observed that fertilization by a male gamete is not proven in this case, though the existence of fertilization of some kind has been demonstrated. Pace (1913, pp. 377-8) records that in *Atamosco texana* a haploid male nucleus, even after penetrating the egg, degenerates, the egg being diploid. Without seeing the fusion it cannot be said that it is the male nucleus which fuses with the egg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in *D. excelsa*. It should be observed that differential staining of the nucleoli in the zygote has not been observed, probably because of the rapidity of nuclear union. Nothing has been observed to cause suspicion of any other source of fertilization than the male gamete. As well as the cases of failure of fertilization in *Fourcroya altissima* and *Atamosco texana* already quoted, that of *Callostemma purpureum* is reported by Schlimbach (1924), where the embryo is developed from the nucellus.

The presence of two differentially staining nucleoli makes the occurrence of a normal triple fusion practically certain. The times of triple fusion and the condition of the nuclei thereat are widely different as reported by many workers. *D. excelsa* is very definite in its fusion of the polar nuclei long before pollination, and in the loosely reticulate condition of the chromatin during triple fusion. In *Cooperia Drummondii* the polar fusion does not occur till fertilization (Church, 1916, p. 400).

THE SEED.

DESCRIPTION.

GENERAL STRUCTURE.

Growth Changes.

In Part 1 of this inquiry (Newman, 1928), the ovule was described up to the time of fertilization, after which it is regarded as having become the young seed. The general changes during maturation, as seen from Plate xix, fig. 45, are: The enormous increase of the embryo sac, from 0·25 to 8 mm. in length, and from a little more than 0·1 to 9 mm. in breadth. In a clear space at the micropylar end of this huge endosperm-filled sac is the small cylindrical embryo. The antipodal pocket is to be seen in seeds at least half grown (Plate xix, fig. 46). Outside the embryo sac the texture of the seed is pithy, giving the wing—a development of the funiculus—a papery appearance. Both integuments increase in size, the outer more than the inner. All tissues of the ovule persist into the seed.

Text-figures 14-24.—Nuclear division at various places in the plant body, showing reduction of the chromosome number from forty-four in the sporophytic divisions to twenty-two in the gametophytic divisions.

14.—Late prophase, in receptacle (nucellus), approximately 44 twined pairs. × 2660. 15.—Metaphase, 44 twined pairs (twining not shown), in receptacle. × 2660. 16-18.—Consecutive sections of nucleus of a microspore mother cell at late prophase; *n*, plasmolyzed nucleolus; 43 chromosomes, the upper chromosomes in each section are more deeply shaded. × 3320. 19.—Two consecutive sections of the anaphase of microspore reduction; 22 and 22 (+ 2 detached bodies) chromosomes. × 2360. 20.—Two consecutive sections of late metaphase in the megaspore mother cell; 22 pairs of chromosomes (the pair of dots on the lower figure are regarded as part of a chromosome pair on the upper section). × 2660. 21.—Prophase of the division of the microspore nucleus; 22 pairs, twined. × 2470. 22.—Two consecutive sections, late anaphase in division of microspore nucleus; 22 and 22 chromosomes. × 2360. 23.—Two consecutive sections, late metaphase of second division in megaspore reduction; 22 pairs, X and Y on both sections are regarded as respectively the same pair (on adjacent planes of focus). × 2470. 24.—Early telophase in three spindles of the third division in the embryo sac (same as Plate xvii, fig. 15); 19 and 21, 22 and 20, 22 (one end only) chromosomes (black one belongs to other end of spindle). × 2360.

Histological Changes.

Much of the enlargement in all tissues is due simply to great growth in the size of the cells whereby is produced the pithy texture. Except in the inner integument, cell division also takes place in all tissues, particularly in the receptacle (nucellus) and parietal (wall) tissue to compensate for crushing and digestion by the enlarging sac. Except at the micropyle, the inner integument is always only two-layered. The outer of these layers retains its parenchymatous nature, becoming somewhat crushed; while cells of the inner layer become filled with a very dense, deeply staining substance to the obliteration of the cytoplasm, and the inner wall becomes thickened and hard. This induration of the walls and contents is most marked in the micropylar region (Plate xix, figs. 39, 41, 45). The absence of cell division in this integument allows the outer to overtop it. A very pronounced feature, about the time of fertilization, is the copious collection of starch round the edge of the chalaza preparatory to the nourishment of the enlarging sac (Plate xviii, fig. 29).

The Embryo.

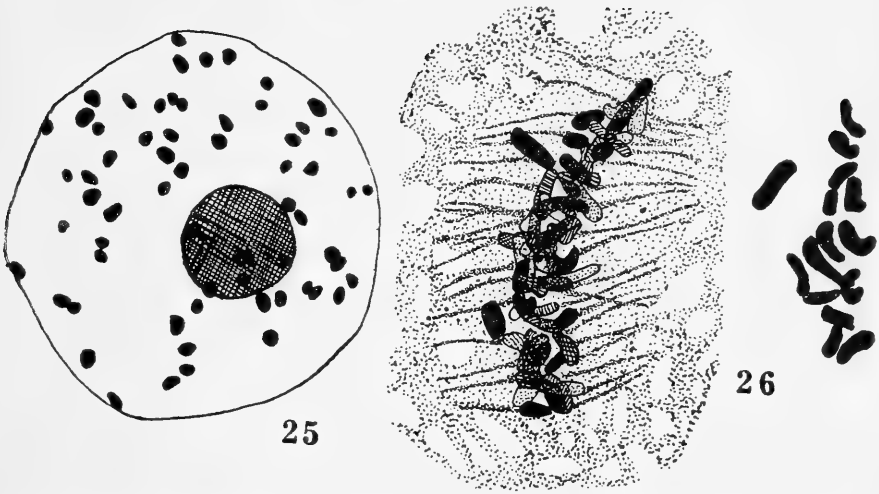
As far as can be seen, fertilization takes place with a nucleolus in both nuclei and with the chromatin in a loose network. The young zygote enlarges and divides by a transverse wall—judging by the only two-celled zygote seen—the upper cell being larger than the lower (Plate xix, figs. 30-32). This division does not occur till the endosperm nucleus has undergone several divisions (Plate xix, fig. 37). Though slightly larger at first, the upper cell does not form a large basal cell. Without special organization, a broad suspensor is formed, at the tip of which the young pear-shaped embryo is developed through intermediate pyramidal and globular stages (Plate xix, figs. 40, 41, 33). At this stage the primordial meristems are organized. With further growth, a depression, representing the origin of the plumule, appears on one side of the embryo (Plate xix, fig. 43), and makes manifest the primordium of the single terminal cotyledon. This soon becomes curved in anticipation of the rolled vernation, and develops a single vascular bundle (Plate xix, fig. 42). The mature embryo is a very small body with a cylindrical outline (Plate xix, fig. 45).

The Endosperm.

Differentiation.

The First Division.

No matter where fusion with the second male gamete takes place, the triploid nucleus goes to the antipodal end of the sac before division. After fusion of the two nucleoli, the nucleus increases in size and the chromatin network with basichromatin lumps becomes very conspicuous (Plate xix, figs. 35, 36). Two figures of this nucleus are shown as being of technical interest; for they are of the same nucleus with only a slight difference in focus, but with slightly different colour filters and different photographic plates—orthochromatic and panchromatic. The chromosomes when first organized are small, but before the metaphase of the first division become very large (Text-figs. 25, 26). Preparations of this division (Text-fig. 13) have not been sufficiently comprehensive to show the process of wall deposition. But at slightly later stages, combination stains show that a wall has been formed (Plate xix, fig. 38), shutting off one of the daughter nuclei into the antipodal pocket, so forming an upper and lower endosperm.



Text-fig. 25.—Endosperm nucleus not long after triple fusion had been completed; 64 small chromosomes are shown; threads connecting these chromosomes are omitted from the drawing. × 3500.

Text-fig. 26.—Two consecutive sections of the metaphase of the first division of the endosperm nucleus. There are 66 (51 + 15) twined pairs, the twining not being shown for the sake of clearness. × 2360.

Free Divisions.

In both parts of the endosperm, free nuclear division goes on for some time —more rapidly in the upper (Plate xix, fig. 38)—till there is a peripheral layer of upper endosperm nuclei in the cytoplasm lining the sac, and a small group of larger nuclei in a dense body of cytoplasm beneath the wall formed at the base of the sac. This lower group now much overflows the antipodal pocket (Plate xix, fig. 44). Two distinct regions of the endosperm are thus differentiated, an upper endosperm and a basal apparatus, both at this stage being still free nuclear.

The Upper Endosperm.

Walls are now formed between the small peripheral nuclei, and divisions begin parallel with the wall of the sac, with such regularity that it appears as if about ten layers have been formed by an alveolar process. After this, the divisions are irregular during the completion of this part of the endosperm (Plate xix, fig. 39). The alveolar structure thins off in the neighbourhood of the embryo, and is not formed above the basal apparatus (Plate xix, figs. 43, 46).

The Basal Apparatus.

The basal apparatus increases in size more by enlargement of contents than by multiplication of its elements, till it covers nearly all of the bottom of the huge sac. About the time when the plumule originates, wall formation takes place, the method not having been observed. The mature basal apparatus appears as a low cushion of large multinucleate, densely cytoplasmic cells, probably still included within a common wall (Plate xix, fig. 46).

Germination.

On 1st April, 1925, forty-two seeds were sown in made-up sandy soil; thirty-two seedlings appeared between 25th May and 11th August of that year. The first leaf was yellow in some cases, turning green later (one took as long as four weeks). One came up quite white, but soon died off. The seedlings suffered very heavily during the first year, some withering and some being destroyed (*e.g.* by hail); nine sturdy ones survived.

Discussion.

EMBRYO.

The embryo has not been worked out in as much detail as desirable. As far as can be seen it appears to be near the *Lilium* type, but towards the *Pistia* type (Coulter and Chamberlain, 1903, pp. 192-5). Stages sufficiently old to permit one to state whether the suspensor continues meristematic activity as in the true *Lilium* type have not been observed. Church (1916, p. 401) describes a very definite basal cell giving rise to a two-celled suspensor in the Amaryllidaceous *Cooperia Drummondii*. Since the *Pistia* type is found in Araceae, Scitamineae and Orchidaceae, while *Lemna* (Caldwell, 1899, p. 37-66) has the *Lilium* type, it seems that not much phylogenetic importance can yet be attached to the growth of the suspensor.

ENDOSPERM.

As usual in Monocotyledons (Hofmeister, 1861, p. 707), endosperm formation begins early and fills the sac before the embryo is completed. Jacobson-Stiasny (1914, p. 553) divides the Liliales into two groups. The Burmanniaceae, Bromeliaceae, Pontederiaceae, and Cabomboideae form immediately two cellular endosperm chambers; the Juncaceae, Liliaceae, Amaryllidaceae and Irideae form immediately a nuclear endosperm. Though a wall is formed after the first division, *D. excelsa* otherwise falls within this scheme. Schürhoff (1926, p. 359) divides the types of endosperm into three main ones having five steps in advancing from the primitive: (1) *Cellular* ("ab initio cellular"); (2) *Cellular* with unequal chambers (bigger cells at the bottom); (3) Endosperm with *Basal apparatus* (in micropylar part always nuclear); (4) *Nuclear* with large nuclei at the base; (5) *Nuclear* with equal sized nuclei. *Doryanthes excelsa* falls within type 3; which is the transition stage between cellular and true nuclear endosperm. The following Amaryllidaceae have nuclear endosperm: *Leucojum vernum* (Hofmeister, 1816, p. 703), *Cooperia Drummondii* (Church, 1916, p. 401), *Narcissus poeticus* (Stenar, 1925), *Spreklia Formosissima* (Stenar, 1925), *Fourcroya Cubensis* (Ernst, 1918), *Bomarea Caldesii* (Stenar, 1925); while the basal apparatus—type 3—is found in *Ixiolirion montanum* (Stenar, 1925), *Hypoxis decumbens* and *H. villosa* (Stenar, 1925), in all of which free cell formation takes place in the upper part but not in the lower part of the endosperm. *Doryanthes* is to be added to these exceptions, but has free cell formation in both parts of the endosperm, being in this regard on the side of the exceptions towards the more advanced type 4. Pace (1913, p. 379) records that, in *Atomosco texana*, at the first division of the endosperm nucleus a wall is laid down, as in *D. excelsa*, but disappears soon afterwards, probably a transition from type 3 to type 4. Schürhoff (1926, p. 484) says the endosperm of the Amaryllidaceae is nuclear (advanced) so that, of the exceptions, *D. excelsa* is the most advanced.

It is to be noted that the only other member of the Agavoideae group listed above has the type normal for the family. Like most monocotyledons, *Doryanthes excelsa* retains its endosperm.

CHROMOSOME NUMBER.

Description.

Counting of chromosomes in divisions at various parts of the vegetative body has given 44 as the diploid number; in meiosis and gametophytic divisions, 22 as the haploid number; and in divisions of the endosperm nucleus, 66 as the triploid number. The details of the examination are set out under "Evidences for fertilization" and "Evidences for triple fusion."

Discussion.

Although the literature available was not exhaustive, yet it seemed that enough chromosome numbers in the Amaryllidaceae had been collected to make it worth while to list them. The species are in an Order which represents, as nearly as a list can, the systematic arrangement of the family by Engler and Prantl (1889, pp. 97-124).

Subfamily and species.	Number.		Author.	Date.
	Hap.	Dip.		
Amaryllidoideae.				
Haemanthus Catharinae	(12)		Stenar	1925
Haemanthus sp.		16-18	Müller	1912
Galanthus nivalus	12		Stenar	1925
Leucojum vernum	12	24	Overton	1893
Nerine rosea		22	Müller	1912
Atamosco texana	12	24	Pace	1913
(= *Zephyranthes* = *Habranthes*)				
Crinum latifolium	(12)		Stenar	1925
Cyrtanthus paviflorus		16	Taylor	1925
Eucharis amazonica		(45)	Stenar	1925
Narcissus (*Pseudonarcissus*)				
cyclamineus		14	de Mol	1922
Narcissus minor		14	de Mol	1922
Narcissus nanus		14	de Mol	1922
Narcissus minimus		14	de Mol	1922
Narcissus poeticus poetarum ..		16	Stomps	1919
Agavoideae.				
Agave virginica (?)	12		Schaffner	1909
Agave americana		20 large many small	Müller	1912
Beschorneria superba		60	Müller	1912
Doryanthes excelsa	22	44	Newman	1929
Hypoxoideae.				
Alstromeria chiliensis	8		Strasburger	1882
Alstromeria pelegrina	8		Guignard	1884
Alstromeria pulchella	8		Guignard	1891*c*
Bomaria Caldesii	9		Stenar	1925
Curculigo recurvata	(10)		Stenar	1925
Hypoxis decumbens	22		Stenar	1925
Hypoxis villosa	22		Stenar	1925

( ) means approximately.

The only comment that can be made on this list, without first making an exhaustive examination and comparison of the characters of the plants concerned, is to point out that the three (out of six) Agavoideae genera represented have large numbers. Especially is this so in three of the four species, including *D. excelsa*.

TABLE OF SYNCHRONOLOGY.

Approx. max. length in cm., or description of flower; or maximum diameter of ovary.	Organontogeny.	Male Gametophyte.	Female Gametophyte.
10	Micropyle; outer integument level with inner.	Vacuolation of the microspore cytoplasm (germination) (Plate xvii, figs. 1-10).	Vacuolation of the megaspore begins (Text-fig. 43 in Part 1).
10·5	Formation of bands of thickening in anther (Text-fig. 15 in Part 1).	Division of microspore nucleus (Plate xvii, figs. 4-10).	Three mitoses in rapid succession at various times within the period forming the eight-nucleate sac (Text-figs. 4-7, Plate xvii, fig. 15).
14	Integs. completed; heavy walls at base of sac begin. Ovule epidermis acquires dense contents (Text-fig. 27 in Part 1).	Fluid matrix used up.	
15	Anther full size; filament continues further growth. Tapetum in pollen sac used up (Text-fig. 15 in Part 1).	Generative cell freed from spore wall (*cf.* Text-fig. 1).	Organization of egg apparatus (cells), and antipodal cells. Polar fusion. Sac ready for fertilization. The stages occur at varying times over the period. Great enlargement of embryo sac and formation of antipodal pocket. (Plate xvii, figs. 12, 13; Plate xviii, figs. 16, 20; Text-figs. 8-10*a*.)
22	Elongation of filament. Flower ready for anthesis. Anther dehiscence begun.	Oil drops on exine of pollen.	

Approx. max. length in cm., or description of flower; or max. diam. of ovary in cm.	Organontogeny.	Gametophyte and Embryo.	Endosperm.
Flower open wide, scarred.	Collection of starch in ovule (Plate xviii, fig. 29).	Pollination and germination (Plate xviii, figs. 23, 24; Text-figs. 1, 2, 3*a*).	
Perianth withering.		Passage of tubes to ovule and probably fertilization (Plate xvii, fig. 14; Plate xviii, figs. 25-28; Text-fig. 3).	Probably triple fusion.
Perianth and stamens fallen.		First divisions of the zygote at any time in the period, but later than corresponding endosperm divisions (Plate xix, figs. 30-32, 37).	First divisions of endosperm and initiation of upper endosperm and basal apparatus (Plate xix, figs. 34-38, 44; Text-figs. 13, 26).
Ovary diam., 2·5.	Enlargement of sac, induration of inner integument (Plate xix, fig. 41).	Sub-globular embryo (Plate xix, figs. 40, 41).	Beginning of alveolar upper endosperm.
Ovary diam., 3·75.		Origin of cotyledon and plumule (Plate xix, figs. 33, 43, 42).	Completion of upper endosperm and basal apparatus (Plate xix, figs. 39, 46).
Ovary diam., more than 5.	Mature seed (Plate xix, fig. 45).		

CHRONOLOGY AND SYNCHRONOLOGY.

Description.

CHRONOLOGY.

There is a very wide time range for all stages. Fertilization may occur any time from early July to late December. Half-grown capsules have been found at the beginning of September, and undehisced capsules as late as April of the following year. Each stage has a season of about five months.

SYNCHRONOLOGY.

The comparative times at which certain of the processes occur are far from constant, so that it is impossible to be precise in some parts of this synchronology. As far as possible the matter has been presented in the form of a table. The time periods are represented by increments in the length of the flower (including pedicle), by the appearance of the flower after elongation ceases and by increments in the diameter of the ovary after the perianth and stamens have fallen. In view of using vacuolation of the cytoplasm as the criterion for germination of the

spore, this table will overlap that given on page 534 of the previous part of this inquiry (Newman, 1928).

Conclusion.

This conclusion concerns the whole inquiry—Parts 1 and 2. In the following list of primitive and advancing features manifested by *Doryanthes excelsa*, some are absolutely, and others are relatively so; reasons for thus regarding them will be found in the foregoing texts. As far as possible the general Amaryllidaceous condition is given with the feature.

Primitive features.

Large size of plant: In common with *Agave* and *Fourcroya* as opposed to small size of other Amaryllidaceae.

Clarity with which leafy-shoot origin of the angiosperm flower is shown.

Semi-epigyny. In common with *Agave* (at least).

Clearness of abaxial placentation of ovules.

Massive sporangial and related structures. In common with *Agave*. Other Amaryllidaceae have some degree of suppression, including *Fourcroya Andina*.

Persistence of parietal (wall) tissue in ovule. Usually destroyed.

Extension in space of fibrous layer in the anther.

Crude stomium.

Absence of periplasmodium in the microsporangium.

Exine on the tapetum.

Simultaneous microspore formation. *Ixiolirion* the only other of the Amaryllidaceae possessing it yet recorded.

Sculptured exine.

Possible central bodies in the division of the microspore.

Eight nucleate monosporial sac. Some members of the Amaryllidaceae have the *Lilium* and *Scilla* types.

Association of two integuments with the above. Some Amaryllidaceae have two, some have one and some have none.

Basal apparatus type of endosperm. Amaryllidaceae with few exceptions have nuclear endosperm. Of exceptions, *D. excelsa* is displaced towards the nuclear type.

Advancing features.

Inflorescence in a compact head.

Restriction in time of fibrous layers of the anther.

Presence of some parallel spindles in second division and evanescent cell plate in first division of microspore reduction (trend to successive division).

Single pore in pollen grain.

Inequality of the daughter cells of meiosis in the ovule (trend to *Lilium* type).

Filiform apparatus.

Insignificant antipodals. Many Amaryllidaceae have prominent antipodals.

In general, *Doryanthes excelsa* is considered to be primitive among the Amaryllidaceae. This conclusion is drawn from the preponderance of primitive

features over those denoting an advancing condition, considering each in comparison with the evidence pertaining to other members of the family.

As far as can be inferred from the evidence available, *D. excelsa* is primitive even among the Agavoideae. It also shows a general condition which may be considered less advanced than the hypogynous *Lilium*. Nevertheless, the signs of advance found show that the species is not static, but still progressing.

SUMMARY.

The polarity of the nuclei in the pollen grain is determined by marked vacuolation prior to the division of the microspore nucleus. After the division, the vacuolation disappears on account of food storage. Dark bodies appear in the cytoplasm as though associated with the division. The normal spindle produced generative and tube nuclei of different sizes.

The lenticular generative cell, in a condition approaching division, precedes the tube nucleus into the pollen tube. The tip of the tube is continually being shut off by cellulosic plugs.

The development of the monosporial eight-nucleate embryo sac is described with special reference to the way in which vacuolation and breaking apart of the cytoplasmic mass determine polarity and function within the sac. The typically arranged egg apparatus has a prominent filiform apparatus. Polar fusion is before pollination, and is usually at the base of the sac. The insignificant antipodal cells show persistence and slight multiplication.

The pollen and flower are adapted to entomophily and avimophily rather than animophily; and there is a simple mechanism to impede self pollination. Bird and insect visitors have been seen.

By means of the cellulose plugs, the pollen tubes have been traced from pollen grains on the stigma through the stylar canal and ovary cavity into the micropyles and on to the synergids. The "conducting" tissue is not continuous with a "placenta" as such. Fertilization by the male gamete has not been seen; but fertilization of some kind has been proved by the demonstration of an embryo and by counting chromosomes.

The presence of two differently staining nucleoli in the first endosperm nucleus, in addition to evidence similar to the above, makes triple fusion with a male gamete practically proven.

Fertilization in both cases seems to take place with the chromatin in a loose network, and with nucleoli present.

The ripe seed has increased enormously in size from its ovular dimensions. Much of the increase outside the sac is due simply to cell enlargement. The inner integument becomes indurated. All tissues persist into the seed.

The small embryo is of the *Lilium* type, but is slightly displaced towards the *Pistia* type. The plumule is lateral and the cotyledon with single vascular bundle is terminal.

The first endosperm division is accompanied by wall formation. The endosperm develops by free nuclear divisions and then wall formation in both parts to a basal apparatus type. The copious endosperm is retained.

Of forty-two seeds sown, thirty-two germinated, and nine survived the first year.

The chromosome number is 22 haploid, 44 diploid and 66 triploid (endosperm). These numbers are high among the Amaryllidaceae, a list of whose numbers is given.

Each stage of development can be collected over a period of five months. Some processes are far from constant in their time relationships. Synchronology is in the form of a table.

After listing primitive and advancing features in comparison with other Amaryllidaceae, *Doryanthes excelsa* is concluded to be primitive among the Agavoideae group and in the Family.

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[1] Both Coulter and Chamberlain (1903) and Schürhoff (1926) give "1900" and "Series III". But Series III is Geology. The paper appears to have been communicated in 1900, and the proceedings of the Botany section not published till 1904.

‡ Cited on the authority of Wilson, 1925.

* Cited on the authority of Coulter and Chamberlain, 1903.

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EXPLANATION OF PLATES XVII-XIX.

All the negatives of these photomicrographs are the work of the author. In about one-third of the cases the negatives were intensified by and prints made by Mr. H. G. Gooch; otherwise the printing was done by the author.

All magnifications are calculated from actual measurement using a stage micrometer.

Plate xvii.

Figures 1-11.—Microspores, showing division of the nucleus, the vacuolation of the cytoplasm, and the presence of the dark cytoplasmic bodies.

Fig. 1.—Two pairs of bodies at opposite sides of the nucleus. Membrane of the nucleus out of focus, nucleolus in the centre. × 734.

Fig. 2.—Nucleus with cytoplasmic body, before division. × 730.

Fig. 3.—Showing vacuolation forcing nucleus to the side opposite the pore (oblique section). × 530.

Fig. 4.—Chromosomes formed. × 685.

Fig. 5.—Metaphase spindle. Vacuolation, and central body at inner pole of spindle. × 681.

Fig. 6.—Metaphase spindle, but with cytoplasmic body lateral. × 683.

Fig. 7.—Anaphase. × 730.

Fig. 8.—Telophase. × 742.

Fig. 9.—Telophase at later stage, with cell plate across widened spindle, vacuolation of cytoplasm and cytoplasmic body. × 667.

Fig. 10.—Division completed, vacuolation still present. × 676.

† Cited on the authority of Schürhoff, 1926.
* Cited on the authority of Coulter and Chamberlain, 1903.
‡ Cited on the authority of Wilson, 1925.

Fig. 11.—Generative cell not yet free from wall of spore. Vacuolation of cytoplasm has disappeared. × 994.

Fig. 12.—Embryo sac ready for fertilization, egg slightly displaced by sectioning, the third antipodal is on the adjacent section (not shown here). The huge nucleolus of the polar nucleus (fusion) shows clearly. × 227.

Fig. 13.—Egg apparatus showing typical arrangement. Section was oblique, hence the egg appears very small (*see* Figs. 17, 18). For synergids, *see* Fig. 16. × 707.

Fig. 14.—Longitudinal section of stylar canal showing the glandular epidermal cells, and pollen tubes with plugs. × 182.

Fig. 15.—Longitudinal section of embryo sac showing late anaphase of the third division in the sac. Both micropylar and part of one chalazal spindles shown (*see* Text-fig. 24). × 693.

Plate xviii.

Fig. 16.—Synergids, showing basal vacuolation, median nuclei, and the filiform apparatus pressed against the parietal tissue. × 502.

Figs. 17, 18.—Eggs with and without central strand of cytoplasm. Part of the synergids visible at the top. Eggs ready for fertilization. × 507.

Fig. 19.—Polar fusion nucleus, with nucleoli not yet fused, near the egg apparatus which has been crushed in the preparation. × 482.

Fig. 20.—Lightly stained egg with heavily stained huge polar fusion nucleus touching it. × 501.

Fig. 21.—Cytoplasm of the sac crushing the antipodals in the pocket. Endosperm nucleus present. × 164.

Fig. 22.—Antipodal end of sac, showing several endosperm nuclei with the three antipodals still present though disintegrating. × 166.

Fig. 23.—Section of part of stigma, showing pollen germinated after twenty-seven hours in a drop of nectar. The tubes appear deep black. × 43.

Fig. 24.—Cleft of stigma, showing empty pollen tubes with plugs. The glandular hairs in this figure appear black, the tubes pale. *p*, a plug. × 117.

Fig. 25.—Longitudinal section of part of the style, showing profusion of empty tubes in the canal which is lined with the conducting tissue. × 117.

Fig. 26.—Showing pollen tubes with plugs in the cavity of the ovary. Notice the heavy epidermis of the parts of two ovules. × 115.

Fig. 27.—Pollen tube with a plug in the micropyle. × 223.

Fig. 28.—Section of the parietal tissue and the top of an embryo sac, showing a pollen tube abutting on the synergids. Egg not shown in this section. × 116.

Fig. 29.—Chalazal region of ovule about or just after fertilization, showing the collection of starch in the outer region of the chalaza. × 107.

Plate xix.

The Embryo and Endosperm.

Fig. 30.—Egg after fertilization, the nucleus containing two nucleoli; central strand of cytoplasm present. Synergids not visible, egg touching the parietal tissue. × 790.

Fig. 31.—Zygote enlarged, preparing for division. Second nucleolus occurs on the adjacent section. Remains of a synergid at the top of the zygote which is touching the parietal tissue. × 797.

Fig. 32.—Two celled zygote, the upper cell being plasmolyzed. × 548.

Fig. 33.—Pear-shaped embryo with broad suspensor. The dermatogen and periblem are completed across the end of the suspensor. × 181.

Fig. 34.—Binucleolate endosperm nucleus, the nucleoli taking stains differently. The stain used in this case was Iron Alum Haematoxylin. × 1106.

Figs. 35, 36.—An endosperm nucleus after fusion of the nucleoli. The focus is slightly different for the two figures. The nucleus was stained with erythrosin and light green which gave red basi-chromatin and green oxy-chromatin. 35 was taken with a G (yellow) filter on an orthochromatic plate; 36 with an E (orange) filter on a panchromatic plate. The filters were Wratten M. × 1059.

Fig. 37.—Embryo sac, showing peripheral upper endosperm nuclei (several divisions having occurred) and an undivided zygote. × 179.

Fig. 38.—Compounded from photos of two consecutive sections, showing the primary basal apparatus nucleus below, and the daughter nuclei of the first division in the upper endosperm above a wall. The stain was erythrosin and light green. By using an E

filter (Wratten M) and a panchromatic plate, the green wall was made to show up darkly against the red cytoplasm and nuclei. It will be noticed that the line joining the photos does not coincide with the wall across the antipodal pocket. × 179.

Fig. 39.—Section, showing part of endosperm, receptacle tissue (nucellus), inner integument and outer integument in descending order. Notice the difference between "alveolar" and irregular tissue in the endosperm. The induration of the inner integument (*i*), inner layer only is clearly shown. × 45.

Figs. 40-43.—Stages in development of the embryo. 40, pyramidal, × 123; 41, globular, notice also the induration of the inner integument—inner layer only—away from the micropyle, × 121; 42, obliquely transverse section of the curved cotyledon, showing the plumule region between the points and the primordium of the single vascular bundle, × 121; 43, origin of the lateral plumule and the formation of the primordium of the terminal cotyledon, earlier stage than fig. 42, longitudinal section, × 121.

Fig. 44.—Free nuclear basal apparatus, with some of the peripheral cytoplasm of the upper endosperm attached. At this stage the sac is about 5 mm. in diameter so that plasmolysis causes great distortion, the peripheral layer of cytoplasm being often bunched into the centre and the basal apparatus pulled away from the antipodal region. × 131.

Fig. 45.—Seed with the sides cut off, showing the enormous sac packed with endosperm. The very small embryo appears as a columnar structure projecting into a clear space at the micropylar end of the sac. × 1¼.

Fig. 46.—Base of the embryo sac in a young seed showing the multi-nucleate, cellular basal apparatus, the antipodal pocket, and the irregular upper endosperm covering the basal apparatus without any "alveolar" formation. The great size of the cells of the basal apparatus is realized by comparing them with the cells of the chalaza below them. × 64.

CORRECTION: *Re Magnifications of Photomicrographs in Part 1.*

These magnifications as given were based on the magnifying power marked on the lenses used. From measurements made since it seems that there is a deficiency of from $\frac{1}{8}$ to $\frac{1}{10}$ in the true values below those given. The factor varies with the optical equipment used.

SOME ASPECTS OF THE STRUCTURAL GEOLOGY OF THE CARBONIFEROUS ROCKS IN THE HUNTER RIVER DISTRICT BETWEEN RAYMOND TERRACE AND SCONE.

By G. D. Osborne, D.Sc., Lecturer in Geology, University of Sydney.

(Plates xx-xxi and one Text-figure.)

[Read 25th September, 1929.]

Introduction and Acknowledgments.
Brief Account of the Distribution and Classification of the Carboniferous Rocks in the Area.
Summarized Statement of the Structure of the Carboniferous Rocks between Raymond Terrace and Scone.
Age Relations of the Folding and Faulting.
Character of the late-Palaeozoic Folding.
Relations of the Regional Structural Features in the Carboniferous and Permian Systems with special reference to the effects of the Hunter Overthrust.
The Development of the Trend-lines produced by the late-Palaeozoic Diastrophism in the Hunter Region.
Summary.

Introduction and Acknowledgments.

The geology of the Carboniferous rocks in the Hunter Valley between Raymond Terrace and Scone, with the exception of the Gosforth and Stanhope districts, has been examined in detail and recorded by the writer during the past eight years. As a result, much information concerning the stratigraphy, structure, petrology and physiography of the area has been obtained. In particular it has been possible to accumulate many interesting data regarding the folding and faulting to which the Carboniferous rocks, and the associated Permian strata, have been subjected. The bulk of the diastrophism probably occurred in late-Palaeozoic time, but there seem to be good grounds for assuming that a later period of diastrophism, apart from the Kosciusko Epoch, affected the area under consideration.

Since the preliminary examination of the late-Palaeozoic folding (Osborne, 1921) it has been possible by extended work in the Carboniferous areas to gain much information concerning this and any later diastrophism.

The present paper is portion of a thesis submitted to the University of Sydney for the D.Sc. degree, entitled, "The Structure of the Carboniferous Rocks in the Hunter River District between Raymond Terrace and Scone, with special reference to the Late-Palaeozoic and probable Tertiary Diastrophism in that Region." In that thesis a full discussion of the structure of the Carboniferous belt was given, including a detailed account of the effects of the Hunter Overthrust upon the Carboniferous rocks, but the present communication is intended to be a dissertation upon certain aspects of the structural geology which have not been given in earlier papers, or have only been treated in a preliminary way. The elucidation of the evolution of the structural features and the tracing of the course of

the late-Palaeozoic diastrophism are undertaken below, special emphasis being placed upon the contribution which the internal evidence of the detailed structure has made to the analysis of the tectonic history, which has also been considered from regional aspects.

Since the preparation of the thesis a very interesting paper has been completed by H. G. Raggatt (1929) dealing with the structure of the Permian areas in the Middle Hunter Valley. Reference to some matters discussed in this paper is made below.

The bulk of the information given on the accompanying maps is from the writer's own work, but he is indebted to certain sources for some details. Thus the data for the Gosforth district are from the map (1926) by W. R. Browne. However, the writer has had the pleasure of seeing something of the Gosforth region while in the company of Professor Browne.

The details in the Permian areas on the map (Plate xxi) are from the maps published by the Geological Survey of New South Wales, in particular the map accompanying Professor David's (1907) Memoir of the Hunter Coal Field. The consideration of the structures in the Lower Hunter Permian area has only been made in so far as it is necessary to elucidate the tectonic history of the Carboniferous rocks. The careful work of the officers of the Geological Survey in the region between Branxton and Muswellbrook which has been going on since 1914 and is still in progress will give much information that bears on some of the subjects considered in this paper. In dealing with the evolution of the tectonics, problems common to both the Permian and Carboniferous Systems arise, and in this connection the writer wishes to state that he has profited by discussing some of these problems with Messrs. M. Morrison and H. G. Raggatt.

In connection with the whole of his geological work upon the Upper Palaeozoic rocks he is very much indebted to Professor Sir Edgeworth David, who originally introduced him to the problems of the geology of the Hunter River region, and who has always shown sympathetic interest and encouragement. The writer is conscious of the help which the pioneering of Mr. C. A. Sussmilch on the Carboniferous afforded him in his early work. Also he desires to record his indebtedness to Professor L. A. Cotton and Assistant-Professor W. R. Browne who have always given every help in connection with his research and have accompanied him into the field and discussed some of the problems. Particularly to the latter he owes very much, on account of constant advice and helpful discussion about Carboniferous matters.

Brief Account of the Distribution and Classification of the Carboniferous Rocks in the Region.

It will be necessary for the purpose of discussing the structure of the Carboniferous rocks to give a very brief account of their distribution and classification. The Kuttung Series occupies the greater part of the region mapped, and in general lies to the south and south-west of the Burindi rocks, which constitute about one-twelfth of the area.

The Kuttung Series outcrops on the eastern coast of New South Wales along the northern portion of Newcastle Bight and at the mouth of Port Stephens, and extends westward towards Clarencetown. The continuity of the Series is broken by the occurrence of two areas of strike-faulted marine rocks belonging to the Permian and Burindi Series respectively.

Between Clarencetown and Lamb's Valley the Kuttung Belt is about twelve miles in average width and its boundaries against the Burindi rocks on the north are very irregular and complicated as a result of the faulting which has broken up the Wallarobba-Welshman's Creek area, where a dome-like structure exists. Throughout the belt westward as far as Eelah the southern boundary has a simple conformable relationship with the Permian system, except where normal cross-faults have broken through this junction, as along the Williams River.

Beyond Lamb's Valley to the westward the Kuttung Series outcrops in a broader belt which, north of Glendonbrook, is probably fifteen or eighteen miles in maximum width. The general trend of the belt is now west-north-west and the southern and south-western margin is the great fault-zone, described under the name of the Hunter Overthrust. This fault continues as the junction between the Carboniferous and Permian nearly to Scone, where the Wingen fault, truncating the thrust, takes up the line of junction.

The Kuttung belt narrows towards the north-west from Glennies Creek as a result of the presence of strike faults which have brought about the outcropping of the Burindi rocks in regions further removed to the west and south-west of the main Burindi belt along the Paterson and Carrowbrook valleys.

The classification of the Kuttung Series in use in this paper and on the accompanying maps is that suggested by the writer in 1922. The Series is divided into three Stages, the lowest being the Basal Stage, which is succeeded by the Volcanic and Glacial Stages. This classification has been found to hold over the greater part of the belt under review. In some places, however, it is difficult to separate the Volcanic and Glacial Stages, because of the absence of some of the indicator horizons which act as criteria in the classification adopted elsewhere in the belt, and also because of the apparent intermingling of some units which elsewhere are clearly separated in the two stages. In other areas there are fairly clear indications of the existence of the two upper Stages with definite limits, but in some cases there has not been time to survey the boundaries between them, and in other cases it is practically impossible to do this on account of the growth of prickly-pear, as in the country east of Muswellbrook and Aberdeen.

Therefore on the map (Plate xx) a certain scheme has been adopted with regard to the application of the items in the legend, and this is indicated in the explanatory note.

The Burindi Series has not been subdivided and has always been considered as one unit in the writer's work. It may be possible with detailed work to make a subdivision, but there is a lack of datum horizons which would aid in classification and correlation of the rocks in the various areas.

Beyond the limits of the map the Carboniferous rocks stretch away in the directions north-west, north and north-east. It is fairly clear that in these regions there are much greater areas occupied by Burindi rocks than by the Kuttung Series, the latter apparently only appearing as infaulted blocks among the somewhat older rocks. This generalization, however, does not hold along the great synclinal trough of the Stroud-Gloucester district where, as shown by Sussmilch for at least the northern portion of the basin, the Kuttung Series outcrops in two parallel belts.

The Kuttung Series bears a conformable relationship to the underlying Burindi Series wherever the writer has been able to study a junction zone, and it

appears as if there are passage beds in most cases, although a great physical change must have affected the areas of deposition and the adjacent region just at the close of the Burindi epoch and the beginning of the Kuttung period. This is indicated, as Sussmilch has clearly pointed out, in the change from marine to freshwater conditions and the development of a great mass of basal conglomerate as the lowest unit in the Kuttung Series of the region between Stroud, Clarencetown and Wallarobba.

As regards the relationship of the Kuttung Series to the overlying Permian System it is only necessary to point out that, apart from the region between Eelah and Scone where a faulted junction exists, there is general conformability between the two. Small changes in the amount of dip do occur at some localities, but there is very little discrepancy in the directions of strike in the two series at these localities, and the variations in dip are generally definitely due to the existence of overlaps of some of the Permian units on to lower horizons in this system and on to the top members of the Kuttung Series. It is clear that the only movement that occurred at the close of the Kuttung sedimentation was a steady subsidence of the land to the south and south-west of the present main Kuttung area.

Summarized Statement of the Structure of the Carboniferous Rocks Between Raymond Terrace and Scone.

1. *The Country between Limeburner's Creek and the Paterson River Valley.* (See Osborne, 1922, 1922*a*, 1925.)

The following structures are present:

(i). The Paterson anticline, the Williams River anticline and the Dunns Creek syncline, all of which merge into a dome-like structure which centres around Wallarobba. In addition there is a number of minor deformations.

(ii). A series of normal faults with an average strike of N. 25° E., this direction being parallel to the general trend of the folds.

(iii). A series of normal faults which strike more or less east and west. These do not seem to be related to the fold-axes.

(iv). A small overthrust dipping to the north-east, which was probably formed at the same time as the Hunter Overthrust (see below).

On the extreme east of the area there is a fault which is a little out of harmony as regards direction with the series mentioned under (ii). This is due to the fact that it is intimately related to the Stroud Basin trend.

The faults have steep dips and the throw varies from 600 feet to a maximum of 6,000 feet. They have produced two senkungsfelder, one horst and a grand series of step-blocks.

2. *The area surrounding Gosforth.* (Browne, 1926.)

This has been described by W. R. Browne and is only referred to here on account of its relations to the general structure of the Carboniferous belt. Browne shows that the main part of the area forms the faulted northern and eastern margins of the Lochinvar dome. The two chief faults, the Hillsborough and the Rosebrook faults, appear to be associated with the late-Palaeozoic and Hunter Overthrust movements respectively.

3. *The area between Paterson and Glendonbrook.* (Osborne, 1927.)

The following structures are present:

(i). The Moonabung basin, the Cranky Corner basin, and the Lambs Valley anticline. The last of these is really the northward prolongation of the Lochinvar dome.

(ii). Two important border faults, viz., the Lennoxton and the Webbers Creek faults.

4. *The Mirannie-Bridgeman Area.* (See Osborne, 1926.)

The following structures are present:

(i). The Bridgeman basin, the Mirannie basin (the equivalent of the Cranky Corner basin) and a very irregular pitching anticlinal structure, which links these basins together.

(ii). Three sets of faults. The first of these trends about N. 28° E., the second has a trend about east and west, and the third group trends in a meridional direction.

5. *The Glennies Creek-Muscle Creek area.* (Osborne, 1928.)

In this area the rocks are broadly folded, dipping in general to the north-east. There is a subsidiary trend superimposed upon the major one, producing the Owens Mount basin, the axis of which strikes E. 15° N.

The faults in this region comprise two main groups and a third and subsidiary group. Of the main groups, one series is parallel to the dominant trend of the sediments, while the other possesses a trend in harmony with the axis of the Owens Mount basin. Those of the third group are practically due north and south in strike.

6. *Area between Muswellbrook and Scone.* (Osborne, 1928*a*.)

The folding in this part of the belt is very open and has produced two shallow basin-like depressions with a complementary structure which connects these. The dominant faults from the Muscle Creek area pass through this area, but the most important additional structure is the Wingen Fault, which begins near Segenhoe and trends N. 13° W., eventually cutting off the Hunter Overthrust. This fault is marked by a remarkable shatter-zone.

Relation of the Faults, with Certain Exceptions, to the Folding.

It is proposed in this section to consider the relationships existing between the faults and the folding in the Carboniferous rocks, excluding the following special cases which will be dealt with separately: the Hunter Overthrust and Lachnagar fault, the Webbers Creek fault, the Benvenue fault and the Manresa fault.

In addition to the faults referred to in the foregoing summarized account of the Carboniferous rocks, there are some minor dislocations which do not seem to fit in with the various definite series of faults whose characters are such that they are to be correlated with the folded structures. The minor fractures include two overthrusts, one of which is probably of the same age as the Hunter Overthrust, and a number of smaller normal faults. As the latter do not appear to be connected with the folding they may be of later age. When one considers that the Hunter region was subjected to the movement which culminated in the Hunter Overthrust and also participated in the uplift of the eastern part

of New South Wales which occurred at the end of the Tertiary (Kosciusko Epoch), one is prepared to find small fractures which may be connected with one of these two periods of movement. It is interesting, further, to note that some of these small faults show evidence of a dominance of lateral over vertical movement on the fault plane, particularly, in one case, by the presence of slickensides. These features suggest that the faults so characterized were associated with the thrusting.

We need pay no further attention to the minor dislocations and therefore pass on to the discussion of the main series of the faults, all of which are of the normal type. One should consult the maps (Plates xx and xxi) for the geographical distribution of the faults and other structural units.

The faults in the belt of the Carboniferous from Port Stephens to Scone may be arranged into the groups given below:

Group A. General trend, N. 10° E.-N. 30° E.—Williams River fault, Glenoak fault, Butterwick fault, Charlton fault, Paterson fault, Lennoxton fault, Main Westbrook fault. (The Lennoxton fault shows a marked variation in strike at its northern end.)

Group B.—General trend, almost due N. and S.—Probable fault east of Limeburner's Creek, east branch of Westbrook fault, Fishhole Creek fault, Mirannie fault, Dry Creek fault, Mt. Olive fault.

Group C. General trend, N. 40° W.-N. 50° W.—Brushy Hill fault, Goorangoola fault, Grasstree faults, No. 1, No. 2, No. 3.

Group D. General trend, E. 10° N.—Owens Mount fault and several small fractures.

Group E. Faults whose tectonic relationships are not clear.—Rosebrook fault, Hungry fault.

The faults of the first four groups are directly related to the folding in the region of their occurrence. Those of the first series, with one exception, occur towards the eastern end of the Carboniferous belt examined, and are parallel to the fold-lines of that region, which run north-north-east and south-south-west. The Westbrook fault, occurring somewhat west of the others, is still within the region influenced by this trend.

The folded structures which all possess this general trend are as follow: Williams River anticline, Dunns Creek syncline, Paterson River anticline, Moonabung basin, Cranky Corner basin, Mirannie basin.

The close agreement in trend-directions and the fact that some of the faults die out and are replaced by broad warps belonging to the fold-system, show conclusively that the two groups of structures, the faults and the folds, were the product of the same orogenic movement.

The second group comprises an interesting series of faults which occur well distributed throughout the belt. At first sight it seems difficult to deal satisfactorily with the relations of these, but a consideration of the structure in the Permian area to the south shows that the Lochinvar dome and other closed structures to the west of it possess a more or less meridional trend. There is evidence that the Lochinvar anticline, at least, was of early formation in the late Palaeozoic diastrophism and it is of importance to notice that at least one of the faults now being considered, the Fishhole Creek fault, is truncated by another in the Carboniferous belt, which itself belongs to the late Palaeozoic folding period. It seems probable then that the Fishhole Creek fault developed early in the orogenic period

and is related to the trend which is so well displayed in the Lochinvar, Belford and Loder domes.

The probable fault near Limeburner's Creek is intimately related to the trend of the syncline between that locality and the coast. And the other faults all show direct connection with the main axis of the Bridgeman basin which is in a north-south direction.

The third group brings us to those faults which are associated with the dominant north-north-west to north-west trend characterizing the north-western part of the belt mapped, and indeed much of the western margin of the New England plateau to the north.

In the fourth group we find only one major fault, and a series of minor dislocations. This, the Owens Mount fault, throws the Glacial Stage occurring south of Owens Mount well down against the lower members of the Volcanic Stage. It is almost vertical and strikes practically parallel to the trend of the Owens Mount basin. The basin is due to cross warping, but it is difficult to correlate its trend with any other structures in the Carboniferous, or in the Permian areas of which maps have been published. Although this difficulty presents itself, there is little doubt that the fault and the associated basin were formed along with the related tectonic units in the course of the late Palaeozoic deformation.

Special Cases.

The description of the Hunter Overthrust is reserved for a separate section, and those faults, specified above as being distinct from the main groups, may now be considered.

The Webbers Creek Fault.—The Webbers Creek fault which occurs near Glendonbrook was first described by Walkom (1913), who showed that it formed the northern boundary of the Cranky Corner basin, truncating that structural unit on that side. Later work has shown that the extension of the fault to the west of that basin is along a direction W. 15° S. as far as the locality where the cross road to Reedy Creek leaves the main Singleton-Gresford road. Here the Webbers Creek fault, the Hunter Overthrust and the Lachnagar fault all meet, but unfortunately it is difficult to make out their relations, because of the prevalence of alluvium. This matter of the relationships between these structures is, however, very important. Since writing on this subject in 1926 (p. 402-3) the writer has made further observations and these are taken into account in the discussion which follows.

Before stating the possible relations between the faults at the critical area near the road-intersection mentioned above, it is important to point out two features of the Webbers Creek fault. Firstly the dip of the fault is to the north at a fairly steep angle, and secondly, the fault shows evidence of appreciable lateral shift having occurred along the fracture-plane. The latter feature is established by the evidence of the positions of the axial lines of the Mirannie and Cranky Corner basins.

The Hunter Overthrust and the Lachnagar fracture can be traced, the former from the north-west and the latter from the south, to the critical area. At this locality there are three possibilities with regard to the relationships of the three faults under discussion. Two of these are similar to each other, being practically variations of the one general idea. (i). The Webbers Creeek fault may be the direct continuation of the Hunter fault, cutting off the Lachnagar fracture, which

itself is a thrust. (ii). The Lachnagar and Hunter faults may be continuous across the critical area, truncating the Webbers Creek fault. (iii). The third possibility is that the Webbers Creek fault may be a steep fracture opened up along the strained overthrust sheet and not extending into the overridden basement. In the last case it is necessary to postulate that the northern part of the overthrust flake has moved ahead of the adjacent southern portion only a small amount, and that the fracture surface of the Webbers Creek fault is not part of the under-surface of the main overthrust sheet.

These possibilities can now be examined in the light of the data to hand for the surrounding region. Thus it is seen that the first hypothesis is unlikely, because there is abundant evidence that the Hunter Overthrust near the critical area, and the Lachnagar fault also, possess low dips, and it is most unlikely, in fact practically impossible, that the base of the Hunter thrust-flake should suddenly change in its attitude to the steep northerly inclined Webbers Creek fracture, particularly also, when just close by the Lachnagar fault shows a high hade.

Then, again, the second possibility does not explain the structural relations of the rocks on either side of the Webbers Creek fault between Glendonbrook and Mt. Tyraman. The facts that the fault dips to the north (shown in the field by the outcrop), and that the Mirannie basin has moved westward, offer opposition to this hypothesis.

Thus we are left with the third case which seems to offer the most reasonable explanation. In the field it is possible to follow the Lachnagar fault quite well as it passes round to the west of a small eminence, known as Tulky's Hill, just south-east of the main road. Then on account of the general dip of the fault indicated just here, and also the occurrence of some Carboniferous conglomerate just north-west of the road, it is seen to be almost impossible for the Lachnagar fault to join up with the Hunter fault as one continuous surface.

Therefore we have in the Webbers Creek fault one of those interesting features often seen in areas that have undergone thrusting which has been sufficiently intense to cause fracture and considerable differential movement. That is to say, there is in this region a steep rift in the thrust-flake along which there has been upward movement of part of the flake, amounting to a subsidiary thrust fault within the sheet, but striking more or less at right angles to the main fracture. This subsidiary fracture no doubt dies out traced downwards, the strain in the lower portion of the flake having been taken up by the elastic strength of the rocks.

Benvenue Fault.—This fault cannot be correlated with any dominant trend in the fold or fault systems in the main Carboniferous belt. It is approximately parallel to the trend of the Owens Mount basin, but it is clear that this trend is a subsidiary and localized one. The strike of the Benvenue fault is practically due east and west, and the outcrop of the fault-surface indicates that the dip is steep, with a downthrow to the south. This view was taken in the earlier paper, but recent studies of the *regional* aspects of the folding and faulting and of the relations of the Hunter Overthrust, have suggested the possibility, that while there has been some subsidence on the south side, the fault developed during the thrusting and was characterized by lateral shift on the northern side. The difficulty in connection with this view is that the Dry Creek fault appears to truncate the Benvenue fault, but at their intersection the writer was not able to settle this point definitely. It is very important to emphasize again the fact

that, in the region immediately to the north of the Benvenue fault, as for example in portion 48, Parish of Dyrring, there are a number of small steep fractures along which there has been much lateral movement productive of slickensides. These faults or slips in the thrust flake are east-west in their trend.

If the Benvenue fault is not related to the thrust as suggested above, then it is part of a trough-fault formation where there has been considerable lateral shift.

The Manresa Fault.—This fault occurs near East Glendon and Mirannie and is characterized by a swinging strike, in spite of the fact that wherever examined it has a steep dip. The fault is definitely offset by the Webbers Creek fault and is found again to the north-east of the Cranky Corner basin, duplicating the toscanite lavas near Mt. Tyraman. Thus some idea of its relative age is obtained, but as it is not related in direction to the fold-lines, it is not possible to say whether the fault occurred early in the course of the thrusting, or whether it is of late-Palaeozoic age.

The Lachnagar Fault.—The Lachnagar fault, as considered in this communication, embraces the original Lachnagar fault of Professor David, its eastward continuation at Gosforth, described by W. R. Browne, and also the northern extension of the fault originally regarded as the northern end of the Elderslie fault, and so considered in the author's account of the Mirannie area (1926).

It is proposed to say very little about the fault, as it has been described fairly fully elsewhere, but the problems of the relations of this fault near Glendonbrook are cognate with those of the Hunter Overthrust.

Browne has given strong reasons for considering the Lachnagar fault, as developed between Lamb's Valley and Eelah, as being overthrust in character, and the present writer thinks that the outcrop to the north of Elderslie can only be interpreted as that of a thrust dipping towards the east. The Geological Survey officers have mapped this fault, and have shown that it is of this type. It would appear that the dip of the fault near Eelah is steeper than that near Glendonbrook.

The relation of this fault to the associated fractures having been dealt with above, it is only necessary to point out that, as a corollary to the view expressed on this matter, and by reason of a consideration of data from the Eelah-Glendonbrook-Westbrook area, the Lachnagar fault must be regarded as part of the Hunter thrust fracture-system. It will be fitting now to consider some aspects of the Hunter Overthrust.

The Hunter Overthrust.

One of the most important tectonic features in the northern part of the State of New South Wales is the fault breaking through the Carboniferous and Permian Systems in the Hunter River Valley, from the neighbourhood of Rosebrook and Eelah to a point just south of Scone. This fault is an overthrust, and has been responsible for pushing the Carboniferous rocks south-westward over the Permian. The fracture embraces the Lachnagar fault at the south-eastern end where there are some very interesting relationships, the discussion of which has been given above.

History of the Investigation of the Fault.—Any geologist examining the upper Palaeozoic rocks between Singleton and Scone would soon become aware of the existence of a strong fault intersecting the Carboniferous and Permian rocks, and no doubt some of the earliest observers were acquainted with this general relationship. The first definite reference to the faulted junction, however, is by the late

Mr. J. E. Carne (1914) who showed the general position of the fault on a reconnaissance map of the Muswellbrook Coalfield. Professor David in the same year (1914, p. 572) mentioned the existence of a thrust fault east of Muswellbrook.

From 1914 until 1921, very little work was done upon that portion of the Hunter Valley along which the fault extends, except in the neighbourhood of Gosforth, where W. R. Browne carried on investigations and noted the existence of a heavy fault affecting both the Carboniferous and Permian rocks. This, he realized, was the continuation of the Lachnagar fault of Professor David, described in 1907, but it was not until more recently that it was recognized as being a thrust.

Judging by the Annual Reports of the Mines Department of New South Wales, it appears that during the years 1921 and 1922 a field party of the Geological Survey under Mr. M. Morrison was concerned in the Hunter Valley principally with the mapping of the extension of the Hunter River Coalfield to the north and north-west, and in the course of examining the limit of the Permian rocks the fault was naturally encountered (see Morrison, *Ann. Rept. Mines Dept. N.S.W.*, 1925, p. 127). From this time onwards the area along the region of the fault from Singleton to Muswellbrook has been surveyed, and a progress report by Morrison and Raggatt upon this later work has just appeared (*Ann. Rept. Dept. Mines N.S.W.*, 1928, p. 111).

Early in 1922 the present writer, in continuation of his studies of the Carboniferous areas near Paterson, investigated this fault at a number of places south of Scone. Thus it was examined briefly to the north-east of Aberdeen, to the east of Muswellbrook, to the north-east of Antiene and to the north of Singleton. What appeared to be the simple continuation of the fault to the north of Scone was also briefly studied at this time.

In 1924 W. R. Browne made a brief examination of the salient features of the geology and physiography of the Scone-Upper Hunter region and described a well-developed fault which separates the Carboniferous and Permian Systems between Scone and Wingen. This fault he named after the latter place and suggested the possibility of its being continuous with the Elderslie fault of Prof. David, which was shown on the latter's map to the west of Brooks' Mountain Ridge on the north side of the Hunter River beyond Branxton, and continuing across the river southward towards Pokolbin. It might be mentioned here that the work of the Geological Survey has shown that the fault is a normal one and that it does not extend as far north as the Hunter River. This fault has been re-named the Matthew's Gap fault, and is referred to by H. G. Raggatt (1929).

Browne was of the opinion that the fault near Scone was a normal one, and suggested its correlation with the Elderslie fault because, at the time, the latter was not known definitely to be an overthrust on the north side of the Hunter River.

But although in 1907 Professor David described the Elderslie fault as being normal, in 1914 he suggested, with caution, the possible correlation of the thrust east of Muswellbrook with the Elderslie and Lachnagar faults, thus apparently recognizing at that time the unity of these last two structures.

In 1925 the detailed investigation of the fault was taken up by the author, particular attention being given to its features as observed along the southern and western boundaries of the Carboniferous terranes. Concurrently with this work the Geological Survey was investigating the fault-zone along the belt between Singleton and Aberdeen. Thus the fault and its effects were being independently

worked out from two sides, the work on the Carboniferous side being carried some distance further north than that on the Permian side.

The outcrop of the fault, as determined by the writer in the district between Singleton and Muswellbrook, and that mapped by the Officers of the Geological Survey agree very closely, being almost identical in places, any variations being due to slight differences in the interpretation of the features to be observed along the fault-zone.

The further examination of the fault between Muswellbrook and Scone was carried out in the year 1928, and also during that period the detailed mapping of the Kuttung Series along that region was completed.

The investigator in the Carboniferous region has a distinct advantage in connection with the examination of the problems of this fault, as compared with the worker in the Permian, because his study is upon the thrust-flake itself and is in the direction of the region whence the thrust came. Further, the Carboniferous of the Hunter Valley provides excellent outcrops on account of its particular stratigraphy and thus gives the key to the details of folding and faulting, and the effect of the thrusting movement upon these structures. In the Permian areas, however, one is dealing with portion of the earth-block which has not moved relatively to the Carboniferous, except perhaps in minor degree, and thus it is difficult to gain information upon some phases of the overthrust movement.

It will be interesting, nevertheless, to see the result of the further work of the Geological Survey in the Singleton-Muswellbrook district, particularly in regard to the possible relations of some of the faults in the Permian to those in the Carboniferous which have been truncated by the overthrust.

It may be noted here that the writer proposed the name "Hunter Overthrust" for the fault at present under discussion. This was considered an appropriate designation because the extent of the fracture is wholly within the valley of the Hunter River, and this stream in places flows in a parallel or sub-parallel direction to the trend of the fault.

The fault has been described under the above name by the writer in two papers published in 1928, but in the Annual Report of the Mines Department for 1928, which has just appeared, the fault is referred to as "The Great Boundary Fault".

Description of some features of the Fault.—A fairly full account of this fault has been given in three papers (Osborne, 1926, 1928, 1928*a*), but there are certain points of interest which still remain to be considered.

An outstanding feature is the evidence which leads to the conclusion that the under-surface of the thrust-flake is distinctly irregular in places, and has been determined by the pre-existing major structures in the Carboniferous rocks which have been fractured. In some places the fault truncates the Kuttung folds and fault-systems in a striking manner, as near Grasstree and to the south of Owens Mount, but in other places the pre-existing tectonic features have exerted a very important influence on the shape and dip of the thrust-surface. Reference to Plate xx will show that in some places the Hunter Overthrust is parallel to the strike of the Kuttung Series for some distance, and then cuts obliquely across some structure, later joining up in direction with yet another trend. These features and other details mentioned in former papers show clearly that, after the thrusting had reached a certain stage, fracturing occurred, the shear-surface conforming somewhat to the major structures of the Kuttung terrane,

where these were likely to assist in giving relief to the strains set up. It must be remembered, however, that a certain amount of differential lateral movement in the thrust-flake would tend to arrange the strata so as to strike in sympathy with a dominant local trend of the fault.

No slickensides have been found on the fault surface itself, but some sub-horizontal markings are present along steep fractures, east of Mt. Dyrring, which strike in a general east-west direction. These are almost certainly the result of differential slipping of portions of the advancing sheet. The Webbers Creek fault and most probably the Benvenue fault are genetically connected with the Hunter Overthrust. Their relations are discussed in full elsewhere in this paper.

It has been pointed out that the throw of the fault is difficult to estimate at any locality, and it has also been found very difficult to obtain much information concerning the horizontal component of the movement. However, it seems that near Gosforth and Eelah this component has been small, but the flake has spread out along the Glennies Creek-Muswellbrook sector. Farther north, near Segenhoe (where, incidentally, the dip of the fracture is low), it appears that the Carboniferous has not been thrust forward as much relatively as in the central zone.

An interesting association along the fault-zone north of Glennies Creek is the presence of much breccia in a pronounced shatter-zone and of masses of Tertiary (?) basalt, which have come up along the fault. In this neighbourhood there is much silification of the brecciated rocks. These have been produced by a fragmentation of both Kuttung and Permian units and some rocks consisting of an intermingling of fragments of both series have been produced. The basalt is present in the form of a sill-like mass, as far as can be made out, but it has completely weathered to form chocolate-coloured soil.

A perusal of many papers dealing with areas where thrust faulting has occurred shows that the Hunter Overthrust possesses features which make it somewhat unique. Thus, in other parts of the world, structures of a magnitude comparable to that of the Hunter fault are generally associated with strong crumpling and shattering which developed during the thrusting. With the Hunter fault there is a noticeable absence of strong deformation in the thrust flake, and the changes which have been wrought in the pre-existing structures by the impress of the thrust-movement are not marked.

This fault, however, is to be distinguished from those thrusts which have developed as a result of a great compression which has metamorphosed, but not crumpled, the sediments. Classical examples of these occur in the Scottish Highlands (cf. Geikie, 1903, p. 562).

Studies during the last twenty years by American geologists, particularly Shepard and Rollin T. Chamberlin and Lawson, upon the relation of the origin of the great mountain chains, such as the Appalachians, Rocky Mountains, Coast Ranges of California, etc., have indicated the important part played by thrusts in the evolution of the tectonic structures. These thrusts are found bordering the great folded tracts, dipping in towards the centre of the range and forming shear planes which in part bound the great segments which have been deformed and uplifted. An almost constant feature of these bordering thrusts is that they possess a low angle of dip. If there are subsidiary thrusts within the central zones or "Graben-like" portions of the ranges, these are often of much steeper inclination than the border thrusts. The mechanics of low-angle faulting and their bearing on this problem have been discussed by Chamberlin and Miller

(1918). The observations of workers on these problems seem to point to most thrusts possessing either a general steep dip or a general shallow dip, with few erratic changes in each case (see Hayes, 1891). The Hunter Overthrust, however, shows some fairly abrupt changes in dip as has been noted above.

It does appear that the Hunter thrust was the culmination of compression that was not intense, when compared with the orogeny which must have operated to produce the low angle thrusts known in many parts of the world. If the compression is intense, there is less likelihood of the base of the flake being in part determined by the pre-existing structures in the overthrust block. As pointed out above, the under-surface of the Hunter fault is somewhat irregular as a result of the influence of original structures in the Kuttung rocks.

The possibility of the overthrust having been a great fracture bordering an ancient mountain range suggests itself, especially in view of the general parallelism (at its northern end) with the tectonic lines which have characterized the south-western margin of New England since Carboniferous times. Now, it is explained below that the age of the Hunter fault is almost certainly post-Triassic and probably early Tertiary. The diastrophism, in which it originated, may have been responsible for the building up of a great mountain range which was reduced to a peneplain by an erosion-cycle which preceded the Kosciusko Uplift, and was distinct from that earlier period of erosion which planed off the Lochinvar anticline immediately following the late-Palaeozoic revolution.

Concerning the important feature of the truncation of the Hunter thrust by the Wingen fault, it is interesting to note that similar relationships occur in a number of American areas. Thus Stillman (1928) describes the association in Utah of a line of thrusts produced during the Laramide revolution and some later faults which were the result of vertical stress during intrusion of igneous rocks along old fractures. Of course, in the present case, we do not yet know the genetic relationships of the Wingen fault. Then again, Longwell (1926), in dealing with some structural features in Nevada and Arizona, describes a series of thrusts probably of the late-Triassic age, which are excellently exposed. These are associated with much intricate normal faulting, some of which intersects the thrust blocks and appears to be connected with a phase of the movement which produced the thrusts.

Age Relations of the Folding and Faulting.

The Folding and Genetically Associated Faults.

The folding and the normal faults which are genetically connected with the former, have affected the Permian and the Carboniferous alike, but there is no evidence available in the area examined as to the exact age of the diastrophism concerned, except that which places an upper limit of late-Tertiary to the interval in which the folding occurred.

This evidence is furnished by a study of the Tertiary basalts in various parts of the area examined. Thus in the Paterson-Wallarobba and Scone districts there are remnants of a peneplain that was carved out of the folded and faulted Kuttung and Burindi rocks. On this peneplain, irrespective of the underlying faults, there are outliers of Tertiary basalt, indicating that the folding and faulting were distinctly older than the basalt.

However, much more definite information as to the age of the diastrophism may be gained in areas beyond the limit of that discussed here. Studies to the south reveal interesting data concerning the relationships of the Triassic and

Permian formations and Professor David considers that the folding which wrinkled the Permian strata was accomplished in pre-Triassic times (1907, p. 339). The distribution of the Upper Coal Measures and the existence of overlapping of these against the Lochinvar anticline led him to conclude (p. 207) that the fold began in pre-Upper Coal Measure time in certain parts of the area. Thus it became customary to regard the age of the diastrophism as being late-Palaeozoic.

More recent work in the Hunter Valley, especially in regions beyond those examined by Professor David, has provided additional information which suggests that some folding occurred in post-Triassic times. This is the view of H. G. Raggatt, who has examined much of the western side of the Hunter Valley and has recently referred to this matter of the age of the diastrophism in a preliminary discussion (Raggatt, 1929) of the structure of this part of the Hunter region.

The present writer considers that the evidence on the south side of the Hunter Valley, together with what is known of the structure in New England and in the Kempsey district, is sufficient to indicate fairly clearly that the bulk of the diastrophism was of late-Palaeozoic age. In the neighbourhood of Drake, strongly folded Permian rocks are overlain by almost undisturbed Mesozoic rocks (Clarence Series). Now Bryan (1925) has discussed the subject of the earth-movements in south-eastern Queensland and has shown that the area was one of dominant subsidence throughout the Mesozoic up to at least the close of the Cretaceous, and that folding occurred after the accumulation of the Burrum Beds. Bryan concludes that there was fairly strong orogeny at the close of the Cretaceous or possibly in the early Tertiary. The Clarence Series is continuous with the Walloon Series of Queensland and it is clear that near Drake there was no folding (on the contrary, only subsidence) in the interval between the Permian and the Lower Cretaceous.

In the Kempsey district, the Upper Palaeozoic rocks are folded and faulted, but the overlying Triassic rocks are certainly much less disturbed. The trends of the Palaeozoic rocks can be traced towards the north-west, linking up with the structures in the Palaeozoic of New England.

The evidence along the western side of the Permian and Carboniferous areas from Aberdeen to Gunnedah is in harmony with the view that the folding of the Upper Palaeozoic was carried out before the deposition of the Triassic, and that later minor warping affected all these rocks. This warping, no doubt, was the result of differential elevation in an epeirogenic period, and similar in origin to the warping to be seen in the Triassic rocks near Barigan, Baerami and along the Kurrajong-Glenbrook-Picton region.

The Hunter Overthrust and the Wingen Fault.

The Hunter Overthrust is apparently of later date than the late-Palaeozoic diastrophism, because (i) it has modified the structures that were fully developed by the completion of that diastrophim, (ii) it shows a trend quite different from the main trends in the Lower Hunter Valley, and (iii) it truncates many of the normal faults in the Kuttung terrane.

The fact has not been lost sight of that an area which has been subjected to compression may possess folds and faults produced in the course of the diastrophism, these structures being cut across by one or more overthrusts of later date, but belonging to the same diastrophic period. A further point to be considered is

that, in the valley of the Upper Hunter, the trend directions developed in the late-Palaeozoic diastrophism are parallel to the general trend of the Hunter Overthrust.

Nevertheless, from a consideration of all the evidence, the writer feels confident in assuming a post-Palaeozoic age for the thrust.

Browne, in discussing the age of the faulting near Gosforth (1926, p. 262), came to the conclusion that the Lachnagar fault (which must be regarded as synonymous with the term Hunter Overthrust in the consideration of any general topic like the present one) was probably of Tertiary age. This conclusion depended on the assumption that the Wingen and Lachnagar (Hunter) faults were parts of the same fracture zone. This, however, is not the case, for the Wingen fault cuts off the overthrust, as shown above.

The Hunter Overthrust, however, can be shown to antedate the Kosciusko epoch which ushered in the Pleistocene, if we consider the physiography from the Lower Hunter right to Aberdeen and Dartbrook, a line of evidence used by Browne in discussing the age of the faulting at Gosforth. Further, the physiographic evidence seems to indicate fairly definitely that the Hunter Overthrust was post-Triassic. For, had the thrust developed soon after the late-Palaeozoic folding and before the deposition of the Triassic, then the upthrown block would have been subjected to erosion in Triassic time and also to the base-levelling that later carved out the late-Tertiary peneplain which was elevated in the Kosciusko epeirogeny to give the present highlands. Now, on account of the great amount of displacement that has occurred along the fault, such extensive erosion would remove so much of the thrust flake as to make it very improbable that the Cranky Corner basin and other outliers would be preserved on the upthrow side.

One has to be very careful not to confuse the issue here. The stratigraphical relations of the rocks in juxtaposition along the fault zone will depend on a number of factors, foremost among which will be the magnitude of the displacement. Erosion will be another factor, but the important feature to be regarded in the present problem is that the Permian terranes along the Lower Hunter probably at least as far north as Branxton were submerged during the Triassic sedimentation. This is clear if we note that the Triassic rocks at Broken Back Trigonometrical Station are 900 feet thick, and at Great Sugarloaf 700 feet thick (cf. Morrison, 1925), thus implying that the shore line was some appreciable distance further north.* Thus, if the thrust developed before, or even during, the Triassic period, the erosion removing the flake in this period would not affect the Permian strata buried on the downthrow side which were under the Triassic sediment.

Assuming the thrust to be post-Palaeozoic, it remains to consider whether it occurred in the Mesozoic or Tertiary Era. A consideration of conditions in Queensland leads to the view that the probable age of the thrust was early Tertiary. It has been pointed out above that Bryan concluded that, after prolonged subsidence during Mesozoic times, a slight amount of folding occurred towards the close of the era, and that a strong crustal movement took place at the very end of Mesozoic times or possibly in the early-Tertiary. Further folding

* Browne suggested that the Triassic sea did not extend to Gosforth, but this is doubtful as the latter place is only sixteen miles from Broken Back Trigonometrical Station.

movements affected parts of Queensland in the Tertiary period. It is to be noted that the general direction of the force which produced the closing Mesozoic or Early Tertiary folding was towards the west-south-west, this being fairly close to the general direction of movement of the overthrust sheet in the Hunter region.

Finally, it should be noted that the age assigned to the Hunter thrust will apply to the Webbers Creek and Benvenue faults, and other small faults related to these.

The Wingen fault presents a difficult problem as regards its age. It possesses a trend parallel to that of the late Palaeozoic rocks of the Scone-Aberdeen district, but as it cuts off the thrust it must be later than the Palaeozoic folds. The possibility of the Wingen fault having been originally a late-Palaeozoic fracture, along which a posthumous movement occurred in Tertiary times, has been considered and rejected, because this carries certain implications regarding the arrangement of the Permian rocks which will not conform to the known facts of the Upper Palaeozoic geology near Scone.

If the Wingen fault continues to Murrurundi, as Browne considers (1926, p. 262), then the determination as to whether it be Tertiary or post-Tertiary will probably be made from a careful examination of the basalts in the region surrounding Murrurundi. One extremely important point, having a far-reaching application to all physiographic studies in the Hunter region, has resulted from the detailed mapping of the Carboniferous rocks along that region. This is that *no strong fault produced by the Kosciusko uplift exists throughout that belt from the Scone Mountain Range to the coast and north-eastwards as far as the limit of the map.* Thus the eminences all along the Carboniferous belt considered here are remnants of one great plateau surface which was elevated without faulting. Possibly this surface possessed some step-like warps, as did the Blue Mountain plateau between Glenbrook and Mt. Victoria. It would seem that the main factor giving rise to variations in the height of the surface was a general tilt which developed in the uplift. This condition certainly obtained from Mt. Dyrring (2,153 feet) towards Port Stephens, and the remnants of the surface of the tilt-block can be excellently seen when one views the Carboniferous highlands from a low hill a little north of Allandale Railway Station. Apparently this tilted surface, of which the following Trigonometrical Stations—Dyrring 2,153 feet, Tangorin 1,532 feet, Johnstone 1,130 feet, Red Hill 1,000 feet, Gilmore 700 feet, and Seaham 565 feet—now constitute residuals, extended, with increasing elevation, through Bell 2,240 feet, and Kangaroo 2,307 feet, on to the Scone Mountain Range and Blacktop 3,297 feet.

No doubt further east and north-east there are Kosciusko-Period faults separating this belt from the highlands of the Liverpool and Barrington Ranges.

Character of the Late-Palaeozoic Folding.

In the summary of the tectonics of the Carboniferous belt, the various folded units have been considered and their general relations given, but the character of the folding and the relation of the surface features to the form of the underlying folded earth-block have not been considered.

Some time ago the writer made a preliminary investigation of this problem (Osborne, 1921), and obtained some interesting results. The plan adopted in analysing the folding was after the method discussed by Rollin T. Chamberlin, of Chicago (Chamberlin, 1910, 1919, 1921).

The principle used was that, provided certain elemental features resulting from the compression of an earth block are known, the nature of the general shape of the block can be determined. Full details of the working out of the analysis are to be found in the papers referred to above.

The result of the analysis was at first very perplexing, since the earth block involved in the diastrophism seemed to possess a very unusual form, the depth varying greatly and abruptly from place to place across the tract. A consideration of the principles of the method, however, emphasized the important part which heavy faulting may play in the determination of the depth of the folded block in a strongly faulted part of a folded tract.

It was seen that the numerical value of the thickness of the folded block is obtained from a fraction whose value is dependent on the measure of the crustal shortening and the average vertical bulging per mile. Thus where heavy subsidence of a sharply corrugated fault-block has taken place, on account of the crustal shortening being high, and *apparent* uplift above the datum plane due to folding being small, the value for the depth of the block is correspondingly small, and clearly is not indicative of the size of the block which, on deformation, produced the corrugated and up-bowed area.

Therefore it was suggested, and is again emphasized here, that in these analytical studies of the depth and nature of deformed blocks in folded regions, it is necessary, after having allowed for all other tectonic factors not directly related to the diastrophism under examination, to make at least two analyses, one upon the folded tract restored from its present structure, and a second upon the folded area restored to the original conditions that would obtain had there been no heavy strike faults. The results of the two determinations can then be compared and a fair idea obtained of the nature of the bounding surface or shear plane forming the base of the fold block.

In many cases of broad folding with associated strike faulting, the faults have originated during the folding, and vertical movement of the fault blocks has occurred during short intermittent periods of relief in the diastrophic cycle, when tensional strains have been set up. But the dominant conditions of compression have continued on to a close, and then extensive settling and adjustment of the fault-blocks has taken place. It is most probable that, while a large displacement between two portions of the earth's crust may be the integrative effect of a number of small slips along a fault zone, still, in areas which show evidence of broad folding and associated strong subsidence of strike fault blocks, the major part of the subsidence takes place after the folding has ceased.

The policy of adopting two sections in fold-analysis, rather than proceeding directly with a section based on an allowance for faulting, is recommended because of the following considerations. In the first place one immediately sees the relation between the faulted portions of the tract and those that have suffered no dislocation. The parts of the tract where adjustments for faulting are necessary stand out clearly, because one generally finds in an analysis the presence of a fairly regular shear-plane under a tract or portion of a tract broadly folded and free from major faults.

Then again, interpretation of the discrepancies, if any, in the first section, may be made along the lines of finding out if the strike faulting occurred intermittently throughout the folding or mostly at the end of the compression. And in general the comparisons of the two sections would be likely to throw light on many problems peculiar to the area examined at any time.

The final results for the section from the coast to Singleton were as follows:

(i). The crustal shortening was such that a strip of country 77·96 miles in length was reduced by 7·46 miles.

(ii). The average vertical bulging over the whole area was 8,000 feet.

(iii). The depth of the folded shell varied from 41 miles to 8 miles, the deepest portions being beneath the margins of the tract examined, and the shallower portion near the centre of the region.

This last item is interesting in that the great Lochinvar dome is near the central zone where the shell appears to be relatively thin.

When the depth of the folded shell is considered in comparison and contrast with the thin-shelled type of the Appalachians and the thick-shelled type of the Colorado Rockies, it would appear that the Hunter folding must be considered as having affected an essentially thin shell. This is supported by the absence of strong resultant vulcanism, which Chamberlin found to be characteristic of the deeply folded tracts; but, on the other hand, there are no thrust faults which have a cognate connection with the folding and which would be expected with a thin-shelled region.

However, there are some aspects of the analysis of the folding in the Lower Hunter which should be considered now. The section examined in 1921 is not a complete one. Chamberlin, in his studies of the Appalachians and the Rocky Mountains in Colorado, was able to carry his section across the greater part of folded mountain tracts and thus lead to the determination of the existence of a wedge-shaped block underlying the Appalachians. Chamberlin more recently (1921) has indicated the application of this principle to other mountain ranges and has developed the "Wedge Theory" of diastrophism (1925).

The Upper Palaeozoic folding extends beyond Singleton to the west and must have extended to the east of the present coast line before the foundering of "Tasmantis", so that there may always be an incompleteness about any analytical investigation of the diastrophism.

However, the careful mapping of the structures west of the area of Sir Edgeworth David's map is being carried on by the Geological Survey and in conversation with Messrs. M. Morrison and H. G. Raggatt the writer has learned of the existence of some folding which must be studied in conjunction with that known for so long to the east, before a more complete conception of the diastrophism is known.

There is one consideration which has some bearing on the question of deciding whether the Hunter folded tract should be regarded as related to the thin-shelled or thick-shelled types in other parts of the world. The late Palaeozoic diastrophism which affected the Hunter region also affected New England, the latter being subjected probably to greater deformation. Now in the New England area there are, amongst the granitic masses, some apparently of late Palaeozoic age (see Andrews, 1908), and these might be the cores of a great mountain range thrown up by the diastrophism. Considering the correlations which Chamberlin has been able to make between the folding of deep tracts and the development of great masses of intrusive igneous rock (see Chamberlin, 1921, p. 171), one would expect to find that the late Palaeozoic bulging in New England was due to the deformation of a very thick block. Therefore the consideration of the relations between the folded shells in the Hunter and New England areas respectively is likely to prove very instructive, and thus is suggested a splendid field for research in tectonics.

Before leaving this aspect of the matter, mention may be made of the occurrence of great masses of basalt near Murrurundi and further north, which may be Upper Permian in age. It is suggested that there may be some causal connection between the earliest phases of the late Palaeozoic folding, which we know began in pre-Newcastle time, and the extravasation of these lavas. If there were some genetic relationship, then, in view of the association of strong resultant vulcanism with deep-shell folding, the Hunter fold-tract, although showing some features characteristic of thin-shelled regions, would be more definitely correlated with the thick-shelled type.

The question of carrying out these analytical investigations upon the Kuttung Series naturally arises. Concerning this the writer is of the opinion that no satisfactory analysis could be made, for the following reasons:

(i). The structures in the Kuttung terranes have been more complicated by the Hunter Overthrust movement than those of the Permian areas. Although, as pointed out below, there may have been a closing of some late Palaeozoic structures in the Permian by the thrusting, it is clear that the measure of the cross sections of the folds has not changed to any appreciable extent. The section examined in 1921 was in most cases, taken across the folds at right angles to the dominant trend which still shows out clearly.

(ii). The Hunter Overthrust has cut obliquely across the Carboniferous trends in places and any lengthy section through the Kuttung belt would have to be constructed of a series of sections extending across from the south-east to the north-west. This would introduce the difficulty of dealing with the Upper Hunter and Lower Hunter trends in the same general section.

(iii). Very little is known about the former extent of the Permian strata in the regions now occupied by the Kuttung outcrops, except that there must have been a definite thinning out to the north of most of the horizons, particularly those in the Lower Marine Series. Very clear evidence of this is obtainable in the Cranky Corner and Mindaribba areas.

Thus it is more satisfactory to confine attention to the Permian areas, particularly where the maximum development of the various series occurs. Thus a fuller understanding of the characters of the folded tract which was deformed in late Palaeozoic time may be expected from future studies of the regions at present unsurveyed or undescribed.

The Relations of the Regional Structural Features in the Carboniferous and Permian Systems with Special Reference to the Effects of the Hunter Thrust Movement.

The general conformable relationship between the Kuttung Series and the overlying Permian strata along the eastern part of the belt examined by the author has been mentioned in an earlier section. The present section deals briefly with a comparison of the structures in the Carboniferous belt and those of the Permian areas between Branxton and the coast, and also with the effect of the Hunter fault on these structures. It is difficult to divorce the Carboniferous from the Permian in any consideration of the tectonics, chiefly because so much depends upon an understanding of the initial features of the diastrophism, and this is not obtainable directly from the Carboniferous, but is best considered by studying the relations of the Upper Marine and Upper Coal Measure groups.

Plate xxi shows the general structural relations of the Carboniferous and Permian Systems. In the latter system the Lochinvar dome or anticline is the great dominating feature, and this merges into the faulted Carboniferous area between Gosforth and the mouth of Lambs Valley. On the eastern side of the Lochinvar anticline there is a series of corrugations carrying across to the basin or senkungsfeld structure south of Limeburner's Creek. These corrugations do not fit in very well with the threefold structure between Paterson and the Williams River described above. In particular one notices also that the strike faults in the Carboniferous area do not show up in the Upper Coal Measures south of the Hunter River, although they affect the earlier divisions of the Permian. This may be due to one of two things: the faults may die out soon after entering the Permian area, or they may have come into existence in pre-Upper Coal Measure (pre-Newcastle) time, and are thus covered by the Coal Measures. The evidence of the initiation of the folding in pre-Newcastle times would lend support to the latter alternative, but, on the other hand, the analysis of the late Palaeozoic folding suggests that heavy strike faults developed mostly at the close of the diastrophism. All things considered it seems more probable that the faults die out quickly to the south of the Carboniferous area.

When we come to the area beyond the north end of the Lochinvar dome and also north-west of this, we find the greatest amount of complexity in the Kuttung belt and the presence of closed structures, there being four basins and two complementary plunging anticlines.

In the Permian area to the south-west of this complicated zone, on the opposite side of the Hunter Overthrust, there are some closed structures cognate with the Lochinvar anticline, including the Belford and Loder domes.

It would appear that the domes or plunging anticlines and the basins in the Kuttung belt were to some extent changed in form by the thrusting which culminated in the Hunter fault. There is evidence of a good deal of differential movement in the thrust flake and a greater spreading of this in the area west and north-west of Glendonbrook. Now this seems to the writer to be due to the fact that the fairly strongly folded tract between Maitland and Singleton, embracing in particular the broad Lochinvar anticline, with its Kuttung core (seen in the inliers at Blair Duguid and Pokolbin), formed a buttress against which the post-Palaeozoic thrusting was directed. The thrusting has without doubt affected the northern ends of the closed folds, as in the case of the Lochinvar dome at Gosforth where the axial line is bent round (see map, Plate xxi).

The present basins and plunging anticlines of the Carboniferous were also modified by the thrust, but there is no evidence which leads one to deduce definitely whether the late Palaeozoic folding produced just plunging folds, or closed structures. The writer inclines to the view that the latter type of structure was formed and modification of these occurred subsequently.

Beyond the complicated region to the north, there is another region of perplexity centring about Wallarobba. Here the confusion of structures is due to the conflict of two trend lines, as explained below. One interesting point should be mentioned about this area. Reference to the maps will show the existence of the Wallarobba syncline, which has been described above as a crinkle superimposed on the main Tyraman-Gresford anticline. Now the presence of the Welshman Creek thrust nearby suggests that the syncline was formed by the dragging-up of the andesite on the north-eastern side, in the manner pictured

by Browne for the production of the "hair-pin" syncline west of Eelah by the Lachnagar fault.

To the north-west of the central complicated region, besides the evidence of differential movement in the Carboniferous terrane mentioned above, there seems to be little in the way of an effect by the thrusting upon the pre-existing structures. Of course, any effect would be difficult of detection, because the late-Palaeozoic trend in the Carboniferous is practically at right angles to the direction of movement of the thrust.

The Development of the Trend-Lines Produced by the Late-Palaeozoic Diastrophism in the Hunter Region.

The detailed information concerning the trend-lines in the Kuttung belt has been presented above, and some references to the directions in the Permian are scattered through the foregoing chapters. It is proposed here to discuss the course of the diastrophism, with its production of the tectonic lines, and to consider the relations which the regional trends throughout the area bear to the country to the north-west, north and north-east.

The map given in Text-figure 1 shows the principal trends in the area examined and in the surrounding region. In the case of the complicated zone between Paterson and Bridgeman, where closed structures occur, only the dominant trends are given, but it is to be noted that some of these closed structures and those south of the Hunter possess an elongated character.

The trends may be summarized as follows:

(1). The N. 15° W.-N. 20° W. trend.—This is dominant along the belt from Glennies Creek to Wingen, and along the valleys of the Paterson and Allyn Rivers.

(2). The N. 30° W.-N. 45° W. trend.—Also seen between Glennies Creek and Wingen, but particularly strong near Hilldale and Bowman's Creek.

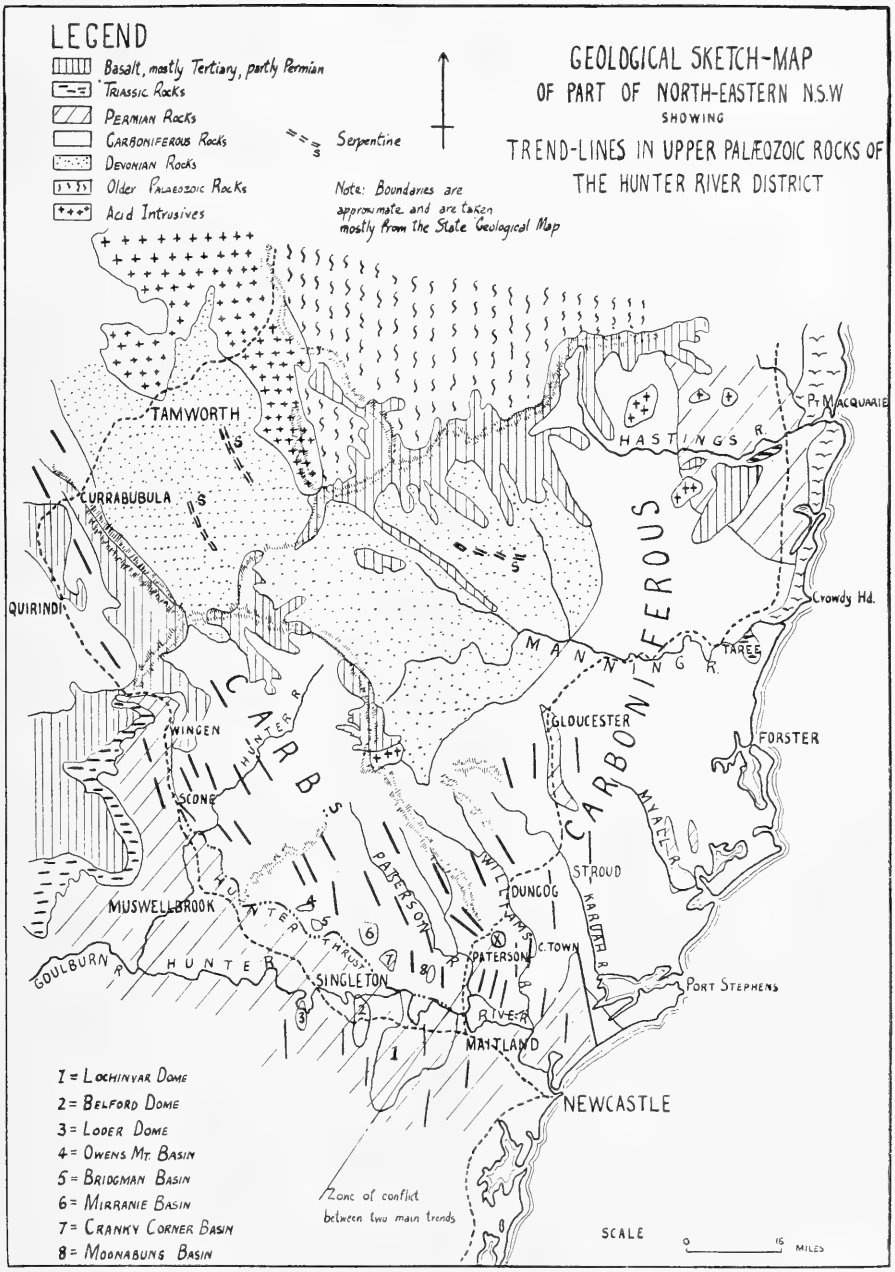
(3). The almost due north and south trend.—This characterizes the great Stroud-Gloucester basin and also the closed structures in the country between Paterson and Maitland, including those in the Permian. One should emphasize that the Lochinvar dome originally had this trend, but apparently has been affected by later movements.

(4). The S. 20° W. trend.—This is well seen between Paterson and Clarencetown.

Professor David (1911) has given a comprehensive treatment of the trend lines of New South Wales and later papers have considered the relations of the Upper Palaeozoic trends and problems of palaeogeography in the Hunter district (see Walkom, 1913; Benson, 1925; Sussmilch and David, 1919, pp. 277 *et seq.*).

The very careful survey of the palaeogeography by Browne (1926, p. 263) contributes much to these problems, and his conclusions apply not only to the Gosforth region but to much of the Lower Hunter.

In the present chapter it is proposed to trace the course of the development of these trends in the light of the knowledge gained from the detailed mapping. On account of the detailed nature of all the dicussions in this thesis, discrimination has been made between trends which, on broader considerations, would be classified into one general tectonic direction.



Text-figure 1.

It is necessary to begin consideration at the close of the Kuttung epoch. There had been high land to the south and south-west of the Hunter region all through the Kuttung period. This point seems to be implied in Dr. Walkom's discussion of the Lower Marine palaeogeography, but prior to this communication (1913), and even persisting on in later years, was the view that the great geosyncline of central eastern New South Wales was a permanent feature from as early as Devonian times.

Benson considered, as late as 1920, that a strong crustal activity affected the western margin of New England, producing the thrust-fault along which the great serpentine intrusion ascended. In his later palaeogeographic paper (1923) he does not mention this movement as specifically affecting the New England district, but refers to the account by Sussmilch and David (1919) of the effects of this late Carboniferous crust-movement in the Hunter region. The former of these authors shows, however, that the movement was only of the nature of a broad warping as no folding occurred. Thus it has had very little significance as far as the trend lines are concerned.

Browne has recently (1929) discussed the age of the Great Serpentine Belt intrusions in New England, and has concluded that to postulate a late-Burindi rather than a late-Kuttung age for the injection of those rocks and the associated diastrophism is more in accord with the facts known about the structure of the Upper Palaeozoic rocks in western New England and the Hunter region.

According to Benson's views, the late Carboniferous compression came from the east or east-north-east, and folded the Devonian and Carboniferous along a north-north-west trend. This trend is dominant in those two systems right along western New England for at least one hundred and fifty miles and south as far as Wingen and Scone. We will return to this matter presently.

It is clear that no fold trends had developed in the Hunter Valley before the deposition of the Lower Marine Series. The Lower Marine sedimentation was extensive south of Lochinvar and a pronounced sag of the earth's crust must have occurred on this axis.

Walkom now pictures the development of inland depressions along part of the zone of the Lower Marine sea by the effect of pressure from the direction east by north. In these lakes the Greta Measures developed.

This movement was the first phase of the late Palaeozoic folding, but it had not yet caused any pronounced trends, except in delimiting the basins of Coal Measure development. While these sediments accumulated, the old land surface to the south and west must have been lowered considerably by erosion and subsidence and eventually the Upper Marine sea transgressed, and thus came into being the great geosyncline which is such an important feature of the tectonics of eastern New South Wales, and which has persisted since Upper Marine time. Whether this geosyncline had an ancestor in a great pre-Devonian trough is beyond the scope of this paper, but it is clear that most of the area was given over to a land mass in Kuttung and pre-Upper Marine time. As Professor David has shown (1907) and others have discussed, the close of the Upper Marine deposition was followed by the first major step in the evolution of the late-Palaeozoic folding. The Permian sediments and underlying Carboniferous rocks were elevated and broadly folded, the trend being more or less north and south. The chief units resulting from this compression were the Lochinvar anticline and the Stroud-Gloucester basin. It is probable that the latter formed an isolated area of deposition during Upper Coal Measure time.

Connected with the folding there developed some normal faults in periods of tension. The faults occurring at this time include the probable one near Limeburner's creek and the Fishhole Creek fault, near Kangaroo Mountain, and also the Dry Creek, Mt. Olive and the Westbrook (east branch) faults. The parallelism of these fractures with the Lower Hunter closed structures is very marked.

The Upper Coal Measures developed during the succeeding period of quiescence and then more thrusting occurred and the great folded tract was elevated. At this stage we see the interaction of certain different trends. The more or less meridional folds maintained their structure and acted as a core against which thrusting was directed from the east and to some extent from the south-west. The pressure from the east was a later phase of the movement initiated at the close of Upper Marine time, and it seems to have acted in a slightly different direction in this second impression. It was responsible for the trends seen in the area between Clarencetown and Moonabung Plateau. The trend here is S. 20° W. At the same time a trend in a general north-north-west direction (but embracing directions in the interval N. 10° W. to N. 45° W.) was developing in the Carboniferous belt right from Scone beyond the complicated area towards the heads of the Paterson, Allyn and Williams Rivers.

The several subsidiary and sub-parallel trends have been shown on Text-figure 1 and discussed in another chapter, and two of these directions are listed at the beginning of this section.

The writer has examined the Carboniferous trends as far as a little east of Gundy and then right across to the south-west of Gloucester, and has found a very marked uniformity in the tectonic lines and an absence of much cross-warping, the folds rather being fairly simple plunging structures.

This general trend links up with that of the Devonian Somerton-Tamworth-Currabubula belt, so well described by Benson (1913, 1917, 1920). The production of these trends, according to Benson, was by folding from the east-north-east, achieved principally in late Carboniferous time, but the detailed mapping of the Carboniferous belt in the Hunter area shows that these trends in the latter region were produced by the late-Palaeozoic folding. Now, with the existence of the great geosyncline, itself elongated in a general north-westerly direction, it is probable that pressure was exerted from the south-west and west-south-west, producing corrugations with north-west to north-north-west strikes. Whether this thrusting from the geosyncline was sufficiently strong to produce all the folding observed is not clear. It is quite probable that pressure from the north-east and east-north-east produced much of the folding. After all the thrust from the geosyncline and the outward creep from the old land mass of the New England region (see Text-figure 1) are movements which represent causally-related phases of the diastrophism under consideration. The fact that the folding of the Devonian and Carboniferous in the Serpentine Belt areas was due to compressional forces from the east, suggests the possibility of a renewal of the forces in late-Palaeozoic time.

Thus, having seen the relations of the tectonic lines in the Upper Hunter and Upper Paterson regions to those of the folded south-western margin of New England, we can turn to the Wallarobba region where we find a conflict in the north-west and north-north-west trends on the one hand and south-south-west trend on the other. The latter do not extend very much farther north, but become merged into the Stroud basin trend. The regional lines of the former

extend along the Allyn River and apparently towards Gloucester. Beyond Gloucester, Benson and Sussmilch (1916) noted the persistence of the north-west trend and the former (1918) has indicated the general unity in tectonic structure of the Devonian and Carboniferous belts right across the Liverpool Range to the Lower Manning.

Thus, to summarize, it is seen from a comparison of the area mapped by the writer with the regions to the north and east, that the Lochinvar anticline-Stroud basin trend is an early one, which was succeeded by the development of a south-south-west trend, and a north-north-west to north-west trend in the northern part of the belt. The latter trend merges into the tectonic lines of south-western New England, and conflicts with the former near Wallarobba. The latter trend also represents a persistence of the dominant trend which was in existence in Carboniferous time, and became revived in the late Palaeozoic diastrophism.

The elucidation of the evolution of the tectonic lines leads us now to see that it is probable the closed structures in the area between Mirannie, Singleton, Branxton and Paterson took on their general character during the late-Palaeozoic folding. That is to say, the later domes and basins were, in the first stages of the diastrophism, and possibly before the completion of the accumulation of the Upper Coal Measures, open folds plunging to the south in the direction of the great Upper Permian geosyncline, but after the main phase of the diastrophism affected the area they became closed structures.

Probably at a much later date, the Hunter thrust increased the complexity of the structures near Hilldale and in the Glennies Creek-Paterson sector.

Summary.

1. The Carboniferous belt between Raymond Terrace and Scone comprises rocks of both the Kuttung and Burindi Series, which have been folded and faulted extensively. A brief account of the structural features is given. It is shown that there are six plunging anticlines, six basins, two plunging synclines and one quasidome. There are no less than twenty-four important faults.

2. The faults are nearly all normal in character and genetically related to the folds. A number of small overthrusts occur, in addition to a strong overthrust, the Hunter Overthrust, which is described fully, special emphasis being placed upon the nature of the under-surface of the thrust sheet. Some interesting relationships between the various fault-systems are discussed.

3. It is shown that very probably the main diastrophism which affected the Carboniferous and Permian rocks was late-Palaeozoic in age. Most of the normal faults and the folds developed during this crustal revolution. Later thrusting produced the Hunter Overthrust, which is thought to be early-Tertiary, certainly post-Palaeozoic.

4. The character of the late-Palaeozoic folding is dealt with and the results of an analysis into the nature of the folded block discussed.

5. The consideration of the effect of the Hunter Overthrust upon the pre-existing structures in the rocks shows that plunging anticlines and synclines formed by the late-Palaeozoic folding, were probably modified to form closed units.

6. The course of the late-Palaeozoic diastrophism and the development of the trend-lines are investigated by a consideration of the detailed structures in the Hunter region and a comparison with structural features in adjacent areas.

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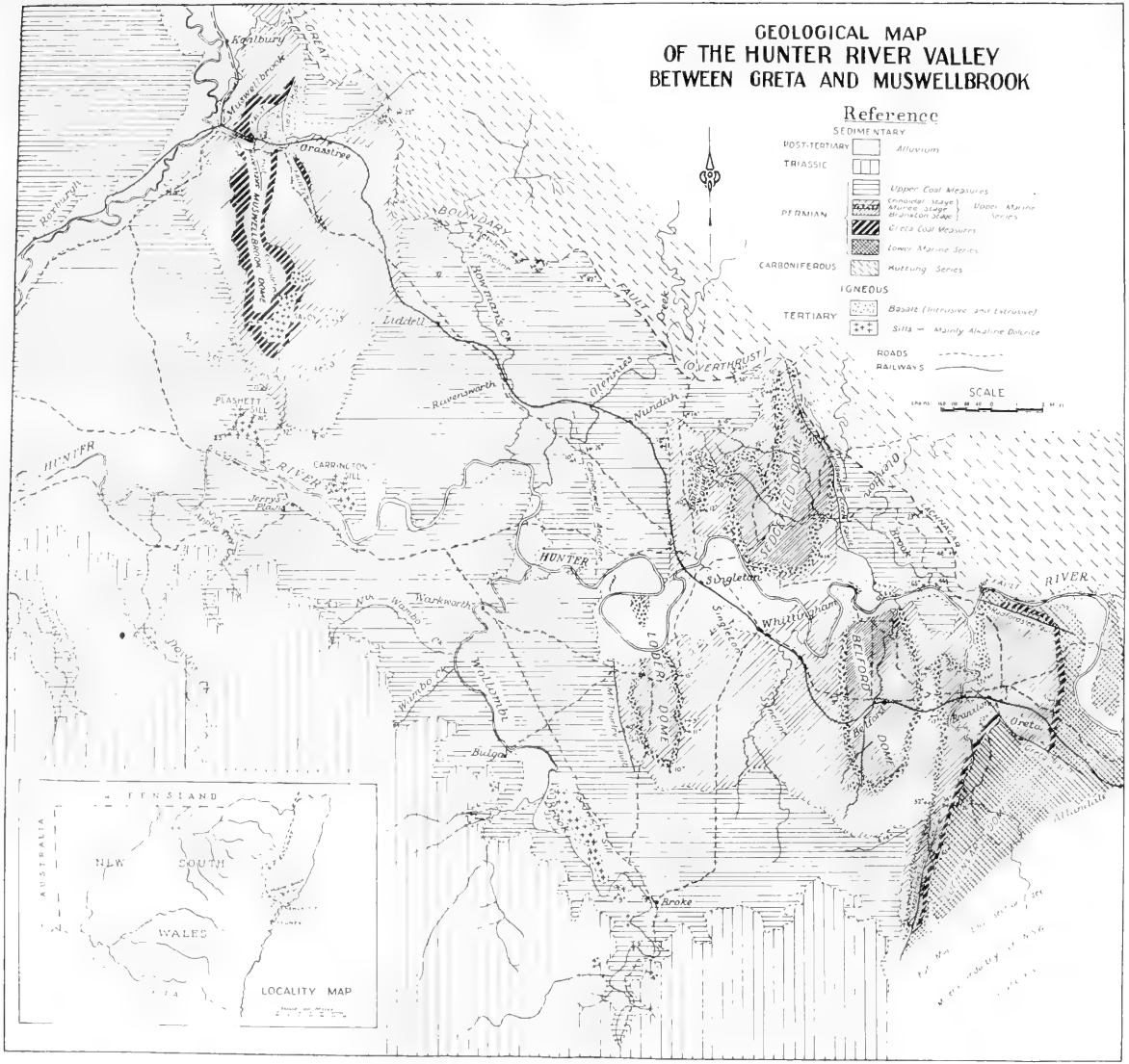
EXPLANATION OF PLATES XX-XXI.

Plate xx.

Geological map of the Carboniferous System between the Raymond Terrace-Clarencetown district and the Scone district, Hunter River Valley.

Plate xxi.

Geological map showing the structural relations of the Carboniferous and Permian rocks in the Hunter River Valley, N.S.W.


GEOLOGICAL MAP
OF THE HUNTER RIVER VALLEY
BETWEEN GRETA AND MUSWELLBROOK
Reference
SEDIMENTARY
POST-TERTIARY
Alluvium
TRIASSIC
PERMIAN
Upper Coal Measures
Crinoidal Stage
Muree Stage
Branxton Stage
Upper Marine Series
Greta Coal Measures
Lower Marine Series
CARBONIFEROUS
Kuttung Series
IGNEOUS
TERTIARY
Basalt (Intrusive and Extrusive)
Sills — Mainly Alkaline Dolerite
ROADS
RAILWAYS
SCALE
Kaalbury
Muswellbrook
Grasstree
Roxburgh
MUSWELLBROOK DOME
BOUNDARY
Bowmans Ck
Liddell
FAULT
Creek
(OVERTHRUST)
Glennies
Ravensworth
Nundah
PLASHETT SILL
HUNTER
RIVER
CARRINGTON SILL
Jerrys Plains
HUNTER
Singleton
SEDGEFIELD DOME
Glendon
Brook
LACHNAGAR
RIVER
Warkworth
Wambo Ck
Wollombi
Wambo Ck
LODER DOME
Whittingham
BELFORD DOME
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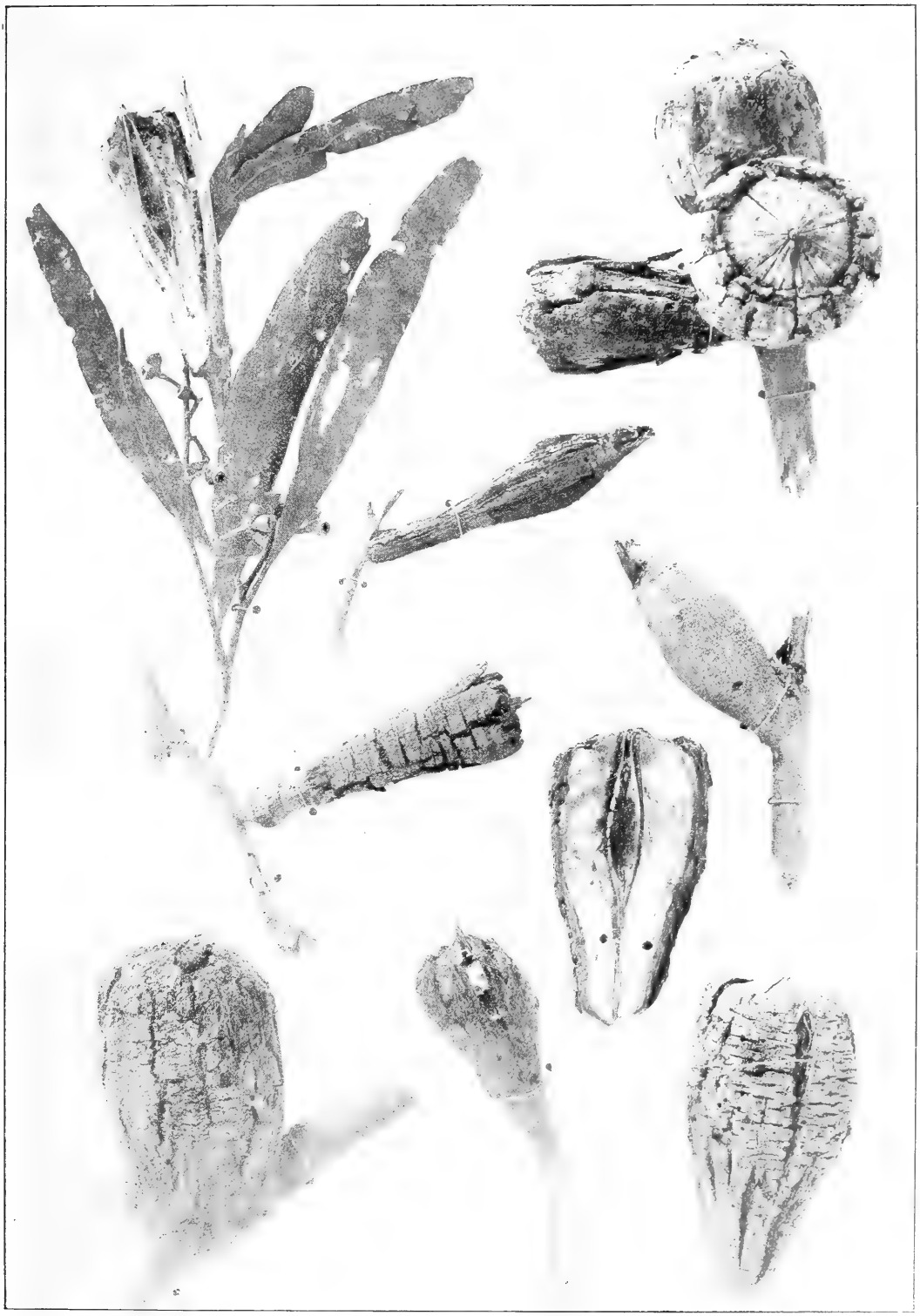
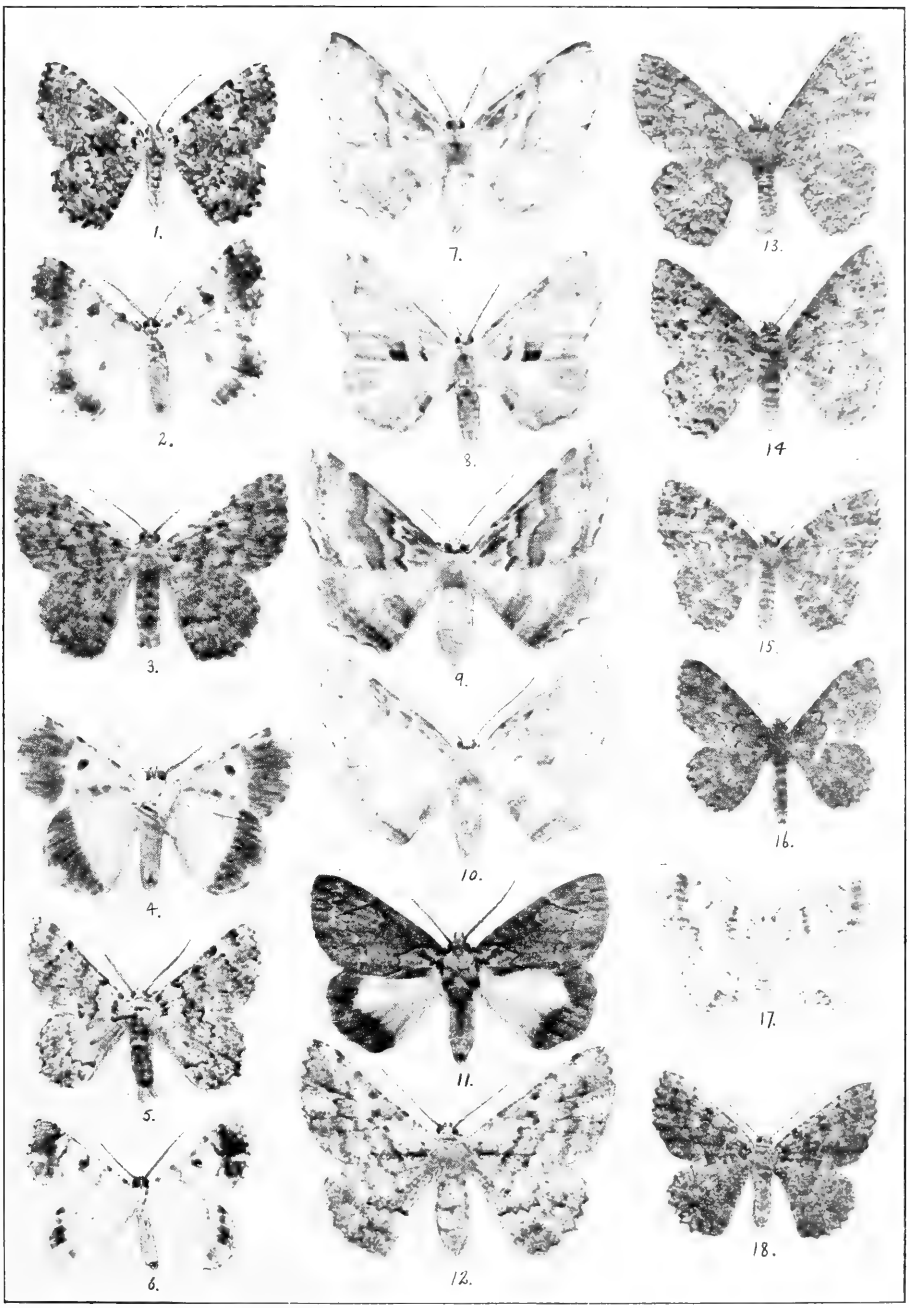
Allandale
FENSLAND
AUSTRALIA
NEW SOUTH
WALES
LOCALITY MAP

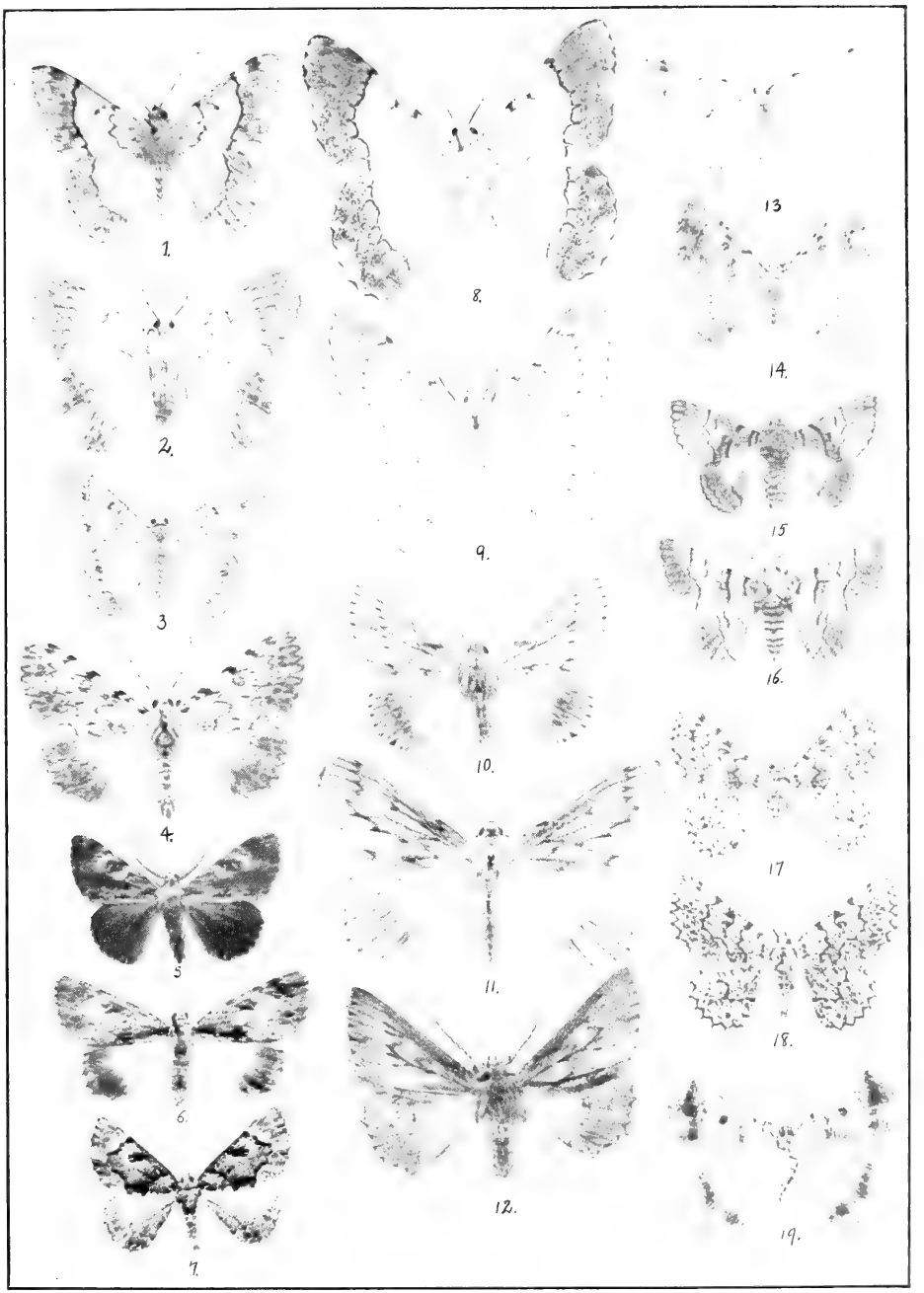


Apiomorpha macqueeni.

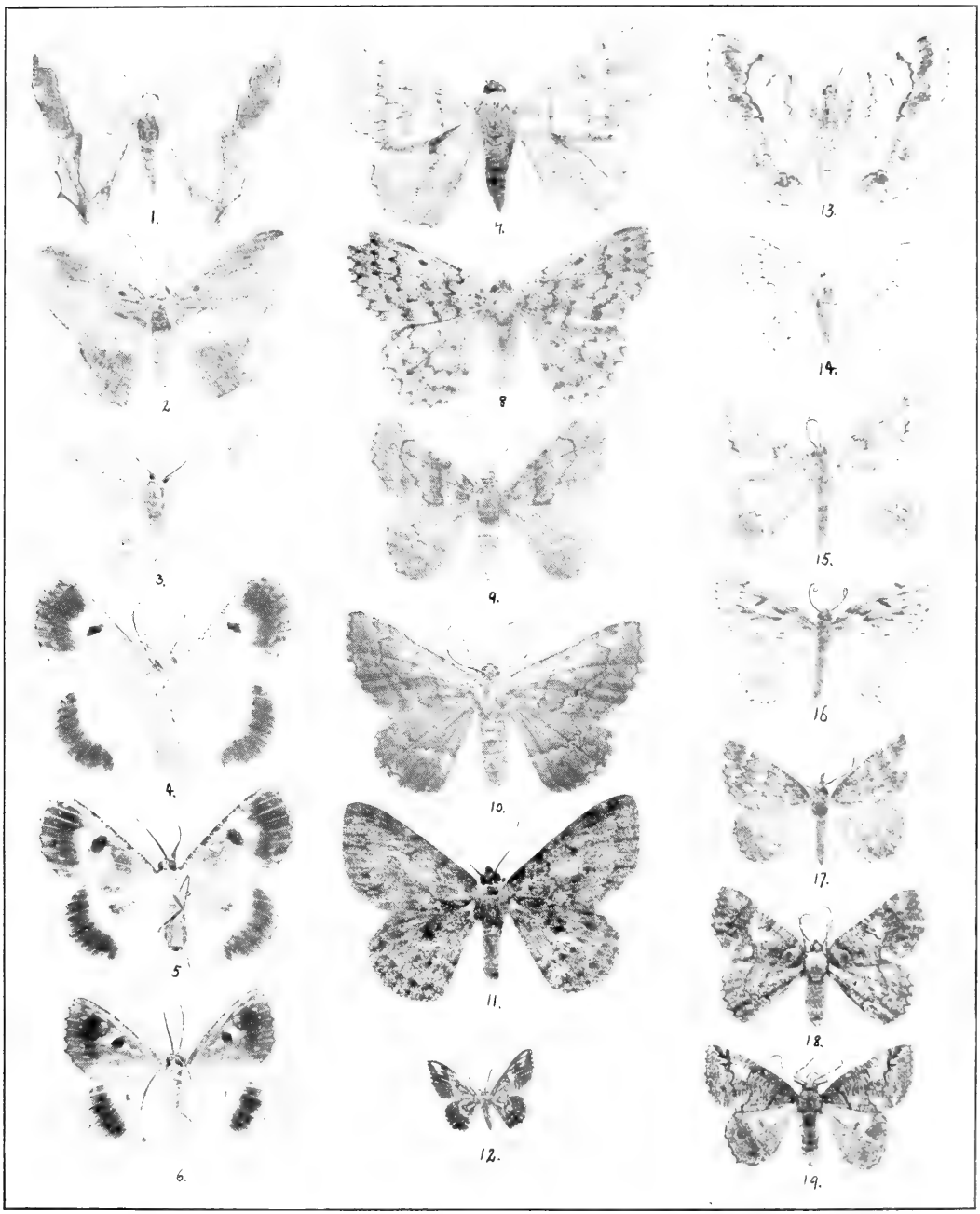
1, 4. *Opisthoscelis maskelli.* 2. *O. globosa.* 3. *O. recurva.*



Australian Geometridae.



Australian Geometridae.



Australian Geometridae.

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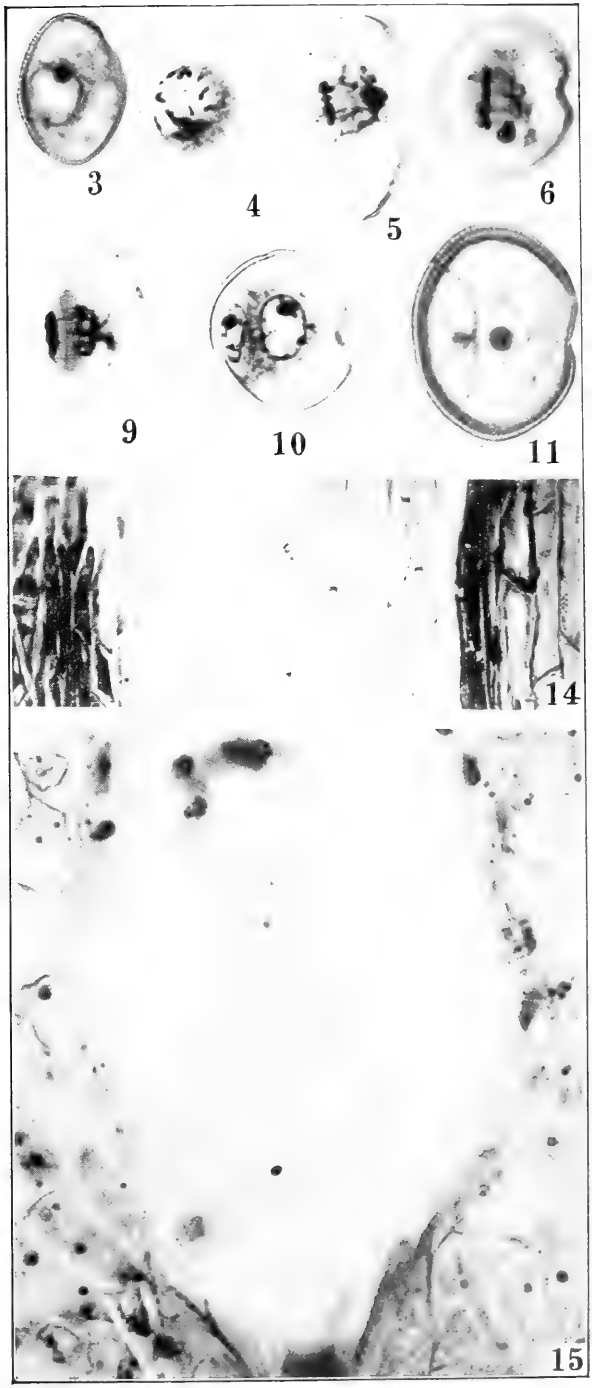
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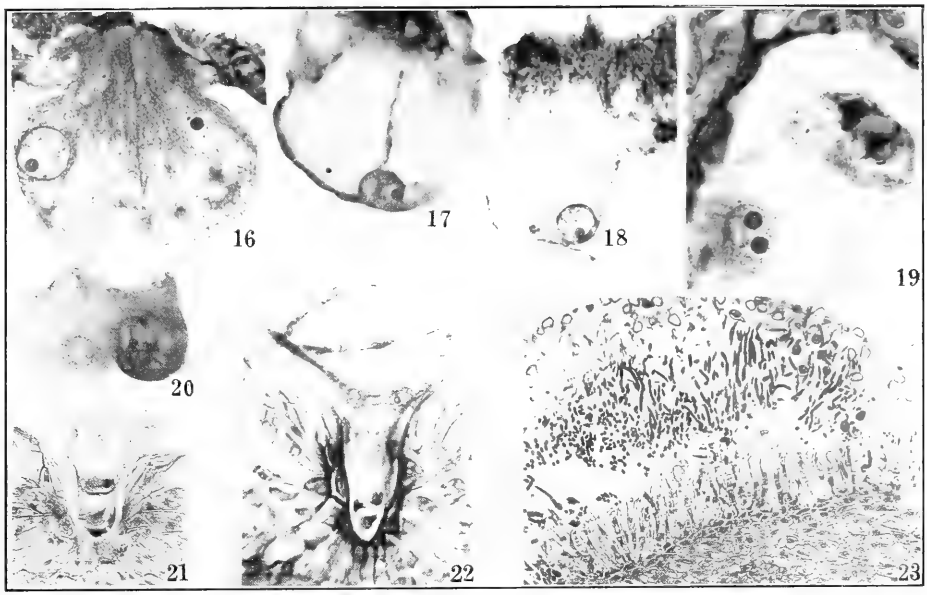
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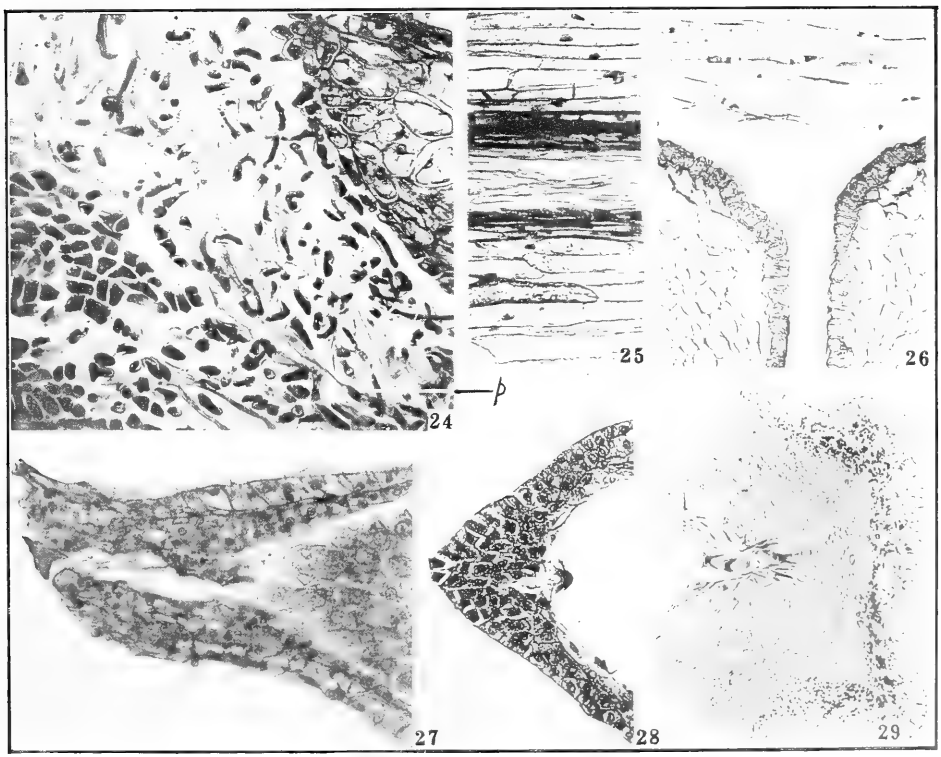
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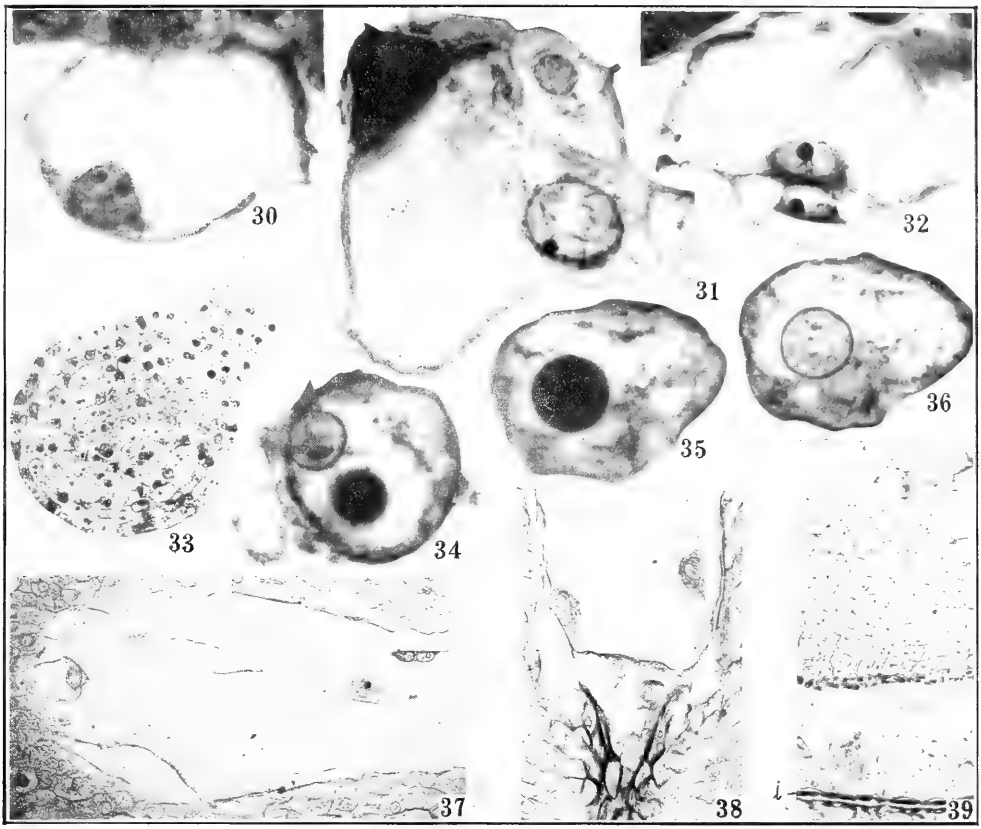
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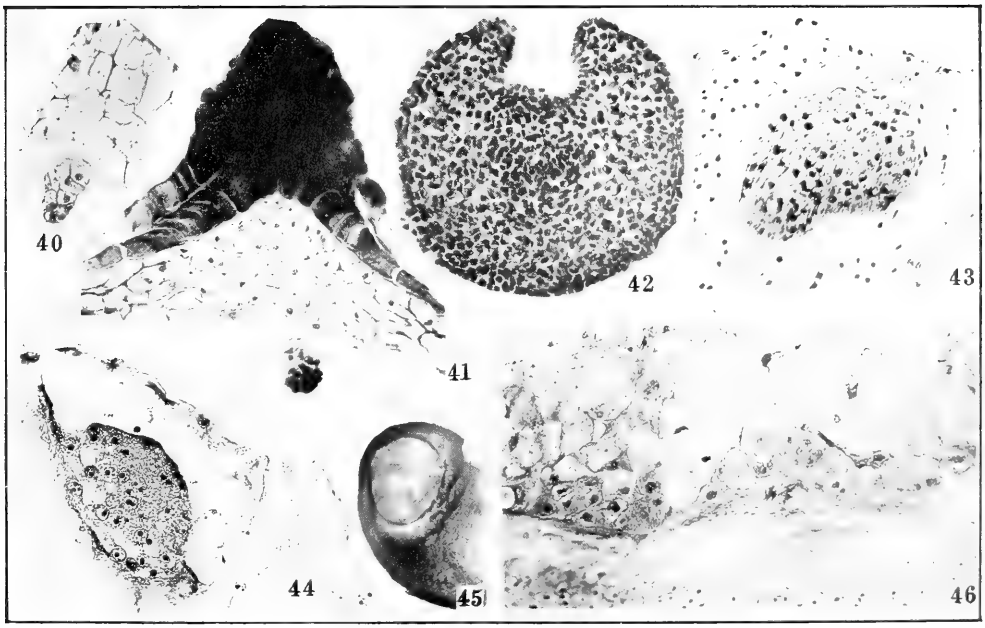
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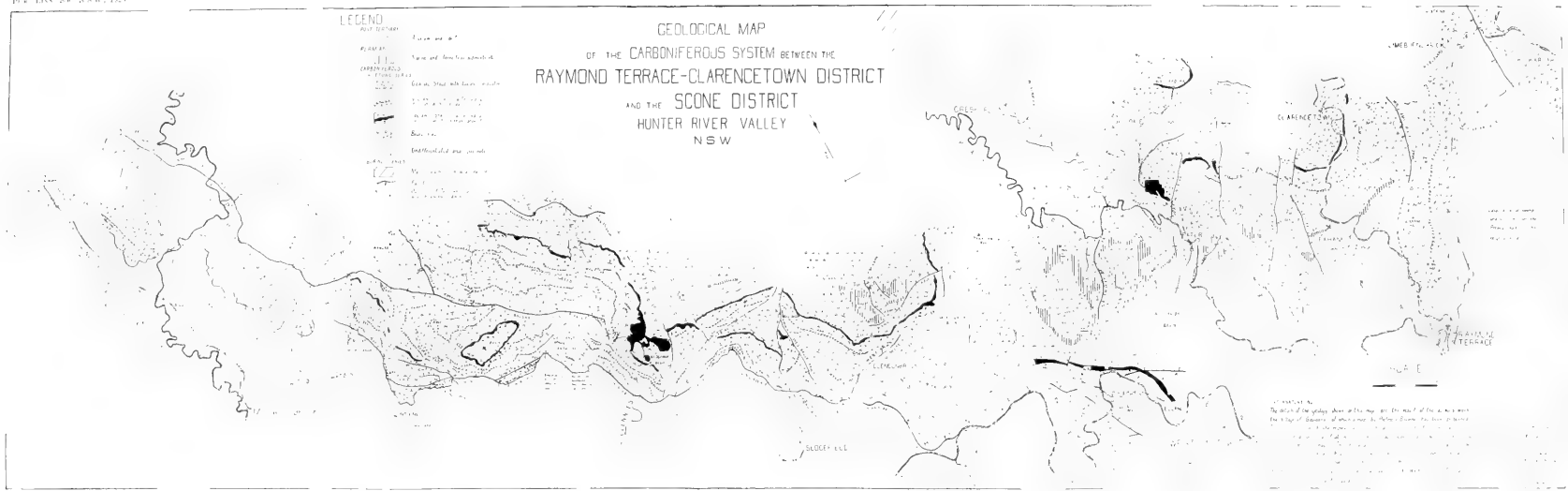
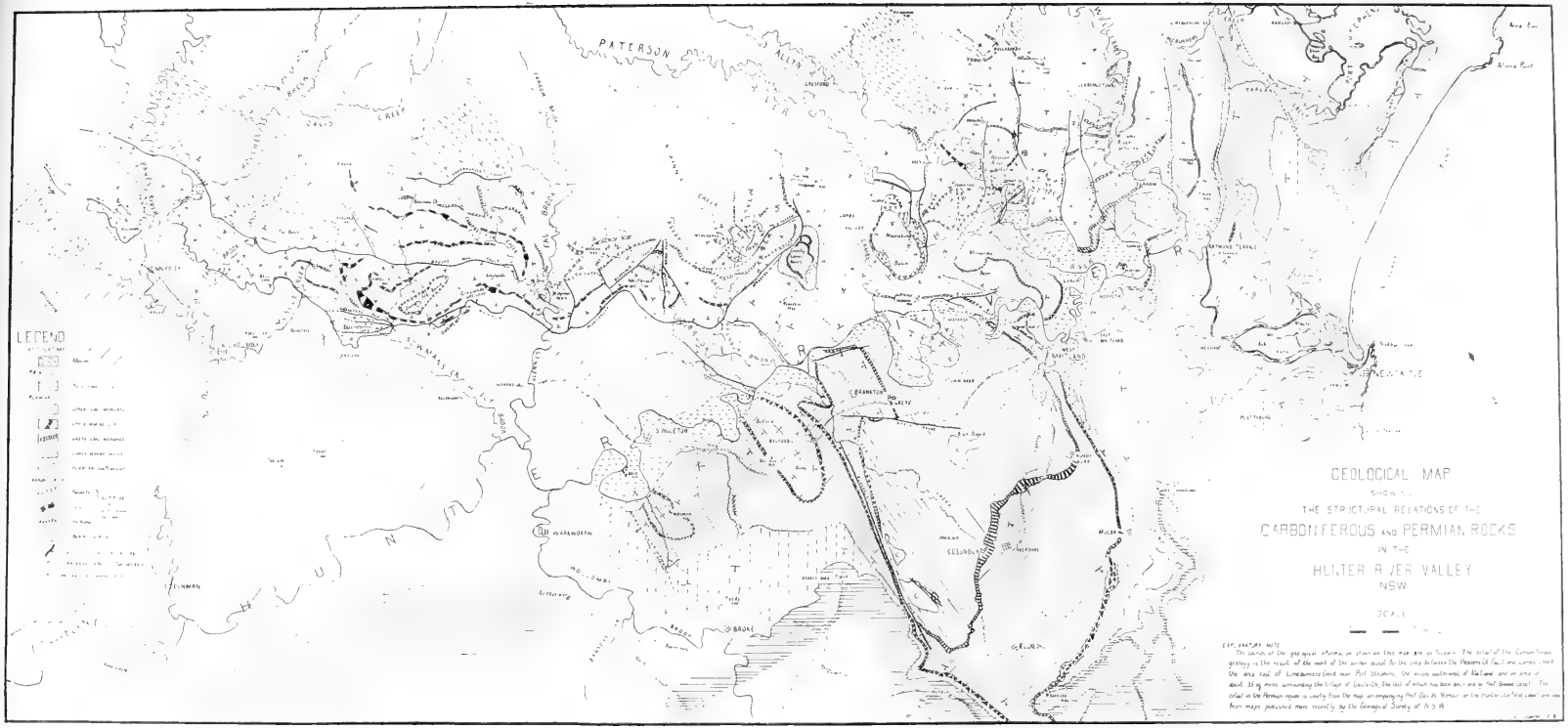

LEGEND
GEOLOGICAL MAP
OF THE CARBONIFEROUS SYSTEM BETWEEN THE
RAYMOND TERRACE-CLARENCETOWN DISTRICT
AND THE SCONE DISTRICT
HUNTER RIVER VALLEY
N S W
SCALE


GEOLOGICAL MAP
SHOWING
THE STRUCTURAL RELATIONS OF THE
CARBONIFEROUS AND PERMIAN ROCKS
IN THE
HUNTER RIVER VALLEY
NSW
SCALE
LEGEND
PATERSON
ALLYN
RIVER
DAVIS CREEK
FAL BROOK
BRANXTON
SINGLETON
WARKWORTH
BROKE
CESSNOCK
MULBAN
MAITLAND
NEWCASTLE
EXPLANATORY NOTE
The sources of the geological information shown on this map are as follows. The detail of the Carboniferous geology is the result of the work of the author based for the area between the Western Ck Fault and Lambs Creek the area east of Lambs Creek near Port Stephens, the areas south-west of Maitland and an area of about 35 sq miles surrounding the Village of Gosforth, the last of which has been done by Prof Browne (1931). The detail in the Permian region is usually from the map accompanying Prof Dav. Mr Vernon on the Hunter Coalfield Lamb and also from maps published more recently by the Geological Survey of N.S.W.

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REVISION OF AUSTRALIAN OENOCHROMIDAE (LEPIDOPTERA). I.

By A. Jefferis Turner, M.D., F.E.S.

(Twenty-six Text-figures.)

[Read 30th October, 1929.]

The family name Oenochromidae was first used by Guenée (*Lep.*, ix, p. 183), though without sufficient definition, and including only the seven genera *Monoctenia*, *Oenochroma*, *Arhodia*, *Phallaria*, *Gastrophora*, *Sarcinodes* and *Hypographa*. The first real foundation of the family is due to Meyrick, who gave (These Proceedings, 1889, p. 1136) a full revision of the genera and species known in Australia at that date. Meyrick, who did not recognize *Oenochroma* as a valid genus, named the family Monocteniadae, but in accordance with entomological usage I have reverted to the older name. In 1910 Prout published a monograph (Genera Insectorum, Fam. Geometridae, Subfam. Oenochrominae) dealing with the group on a world-wide basis, and it is hardly necessary to say, that I have found his careful work of the greatest help in preparing this revision.

The moths commonly known as Geometers were early recognized as a natural group, which has been treated by many authors as a single family, the Geometridae, divisible into several subfamilies, of which the Oenochrominae is one. The main reason for this has been probably that superfamilies are not recognized by these authors. The differences between the Larentiadae, Sterrhidae, Geometridae, Boarmiadae and Oenochromidae are certainly greater than those between the Arctiadae, Nolidae and Noctuidae, or than those between the Hypsidae and Lymantriadae, and I agree with Meyrick that they have equal if not greater claims to family rank. It might be natural then to combine them in a superfamily, the Geometroidea. This I regard as untenable, on account of the very close structural similarity of the more primitive Boarmiadae and Oenochromidae with the Notodontidae, the only absolute distinction present in the Geometrine families being the curved base of the costal vein of the hindwing usually so pronounced as to form a humeral angle. Certainly the Notodontid and Geometrid larvae have specialized in very different directions, but if the more primitive larvae of the two groups are compared, for instance, those of *Brephos* and *Pygaera*, not much difference will be found. It must be remembered that the phylogenetic relationship of any families is determined entirely by that of their most primitive genera. I refer all these families, therefore, to the Notodontoidea, and in this I agree with Meyrick, but as the Geometers remain a natural group, and it is convenient to have a name for them, I propose to write of them as the Geometrites.

The Oenochromidae are of special interest to the Australian entomologist, for it is in his continent only that they are at all numerously developed; in all other regions they are represented by few and often isolated genera. I imagine that at the period when the ancient Austral Land, which now forms the western half of Australia, was first separated from Southern Asia, the Larentiadae, Sterrhidae

and Geometridae had not yet evolved, and the Boarmiadae were still a restricted group. The subsequent development of these families has superseded, and to a large extent probably exterminated, the more primitive Oenochromidae throughout the world. In Austral Land, now merged in Australia, sheltered from this competition, they developed two considerable groups—the *Dichromodes-Taxeotis* group and the *Oenochroma-Hypographa* group—together with many genera not closely connected to either. Subsequently a few species of Papuan or Indo-Malayan origin entered Queensland, *Eumelea*, *Sarcinodes*, *Physetostege*, *Noreia*, *Celerena*, *Ozola*, *Derambila*, but these form but an insignificant addition both in numbers and range of distribution.

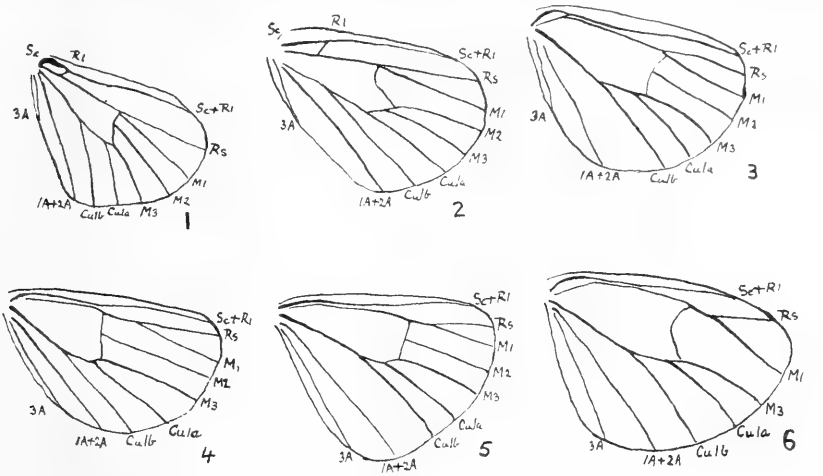
The Oenochromidae display considerable variation in structure, and being the most primitive Geometrites they throw much light on the phylogeny, not only of the group as a whole, but also of its constituent families. This I propose to illustrate by some figures of their neuration, using instead of the numerical notation employed elsewhere in this paper a morphological notation, which is that of Comstock and Needham as modified by Tillyard. The two notations are tabulated thus:

	Numerical.	Morphological.	Contracted into.
Forewing:	12	subcostal	Sc.
	11, 10, 9, 8, 7	first, second, third, fourth and fifth radial	R_1, R_2, R_3, R_4, R_5
	6, 5, 4	first, second and third median	M_1, M_2, M_3
	3	first division of first cubital	Cu_{1a}
	2	second division of first cubital	Cu_{1b}
	1*b*	first anal + second anal	1A, 2A
Hindwing	as forewing, except	vein 7, and vein 1*a* which is the third anal	3A
	7	Radial sector (which does not divide in the hindwing)	Rs

In both wings Cu_2 (1*c* in the numerical notation) is absent.

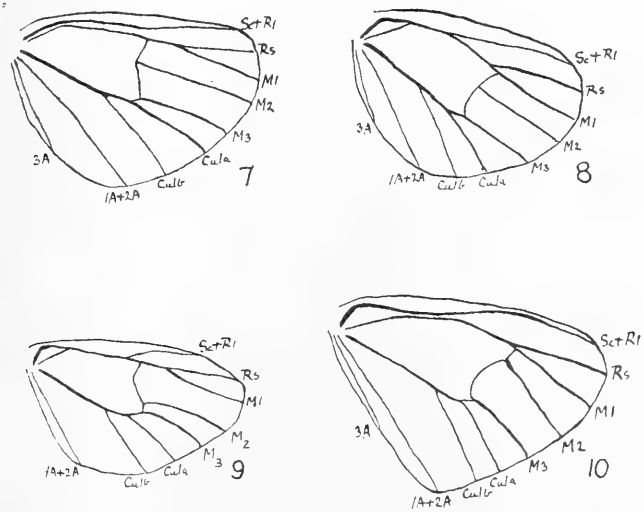
Commencing with the hindwing, Figure 1 shows its structure in *Celerena*. The humeral angle of Sc is not very marked, it is well separated from the cell, from near the base of which it is joined by R_1. This is a primitive neuration, found for instance also in the primitive, but quite unrelated, family Anthelidae as shown in Figure 2. Early in the development of the Oenochromidae there arose a tendency to the close approximation of the united veins Sc + R_1 to the cell, as shown in *Zeuctophlebia*, Figure 3. Note that the anastomosis of R_1 with Sc is still retained. In most cases with this approximation the basal portion of R_1 has failed to chitinize, and therefore does not appear in the imaginal neuration, although it would almost certainly appear in the tracheation of the pupal wing. This structure is illustrated by *Xenogenes*, Figure 4, in which the basal curvature of Sc is only slight, so that its neuration is nearly identical with that of *Diceratucha*, Figure 5, a genus usually referred to the Oenochromidae, but which I believe to belong to the Notodontidae. Figure 6 is that of *Dirce*, a primitive genus of the Boarmiadae, which are distinguished by the absence of M_2. *Epicoma*, a genus of Notodontidae, is shown in Figure 7 to have the same neuration as *Diceratucha*. In three unrelated genera of Oenochromidae, Sc has become fused

with the cell for some distance; they are *Gerusia* (Figure 8), *Macroctenia* and *Lissomma*, with which is associated *Dinophalus*. This structure is a character



Text-figs. 1-6.
1.—*Celerena griseofusa* Warr. 2.—*Anthela xantharcha* Meyr., hindwing.
3.—*Zeuctophlebia squalidata* Wlk. 4.—*Xenogenes eustratiodes* Prout.
5.—*Diceratucha xenopis* Low. 6.—*Dirce lunaris* Meyr.

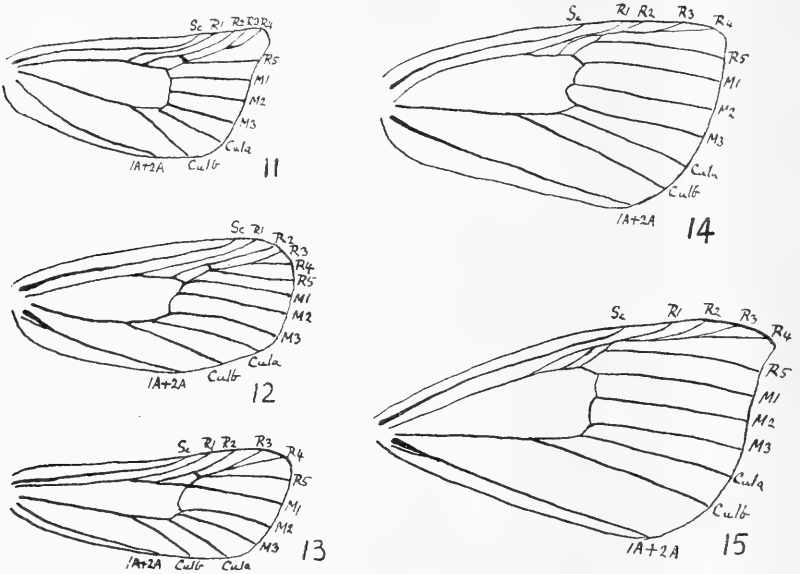
of the family Larentiadae (Figure 9), and its method of development in that group is now evident. Yet another development occurs in the genera *Axiagasta*, *Cernia*, *Monoctenia* (Figure 10), *Anticteni*a, *Gastrophora*, *Circopetes*, M_2 arising



Text-figs. 7-10.
7.—*Epicoma tristis* Lewin. 8.—*Gerusia excusata* Wlk.
9.—*Cidaria subochraria* Gn. 10.—*Monoctenia falernaria* Gn.

from above the middle of the cell approximated at origin to M_1. This structure is characteristic of the family Geometridae (Figure 25), indeed the neuration of *Cernia* is exactly that of this family in both wings, although its affinities to other genera of Oenochromidae are close. In *Sarcinodes* this peculiar character is pushed to an extreme, M_2 arising from very close to the upper angle of the cell.

The neuration of the forewings is rather more complex, and has not been so well understood. Particular attention should be given to the radial veins. The most primitive forewing is that of *Xenogenes*, Figure 11. Here veins R_2 and R_3 are stalked from the cell, while R_1 remains free. Soon after its separation R_3



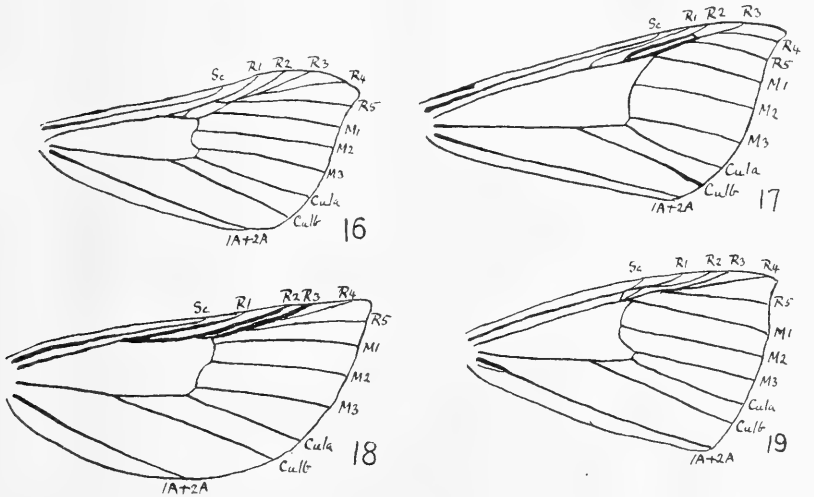
Text-figs. 11-15.
11.—*Xenogenes eustratiodes* Prout. 12.—*Neola semiaurata* Wlk.
13.—*Eremochroa alphitias* Meyr. 14.—*Dichromodes stilbiata* Gn.
15.—*Epidesmia hypenaria* Gn.

anastomoses with R_4, forming the "accessory cell" or "areole," from which R_3 separates independently. An areole of this type is present in many families, for instance in the Notodontidae, Figure 12, and the Noctuidae, Figure 13. The phylogenetic importance of the areole has not been sufficiently appreciated by lepidopterists. It is present in the more primitive genera of the Notodontoidea, Noctuoidea, Drepanoidea, Tineoidea, Castnoidea and Cossoidea. In the Rhopalocera it has disappeared in the adult wing, but is present in the pupal tracheation, and there is no reasonable doubt that the same will be found to hold true of the Zygaenoidea, Pyraloidea and Pterophoroidea. In the Homoneura it is always present in the Micropterygoidea, although absent in the Hepialoidea. A precisely similar structure is found in the Trichoptera and Mecoptera, where it is known as the radial cell. This would be its correct name in the Lepidoptera also, but as in that family the term "cell", as applied to the neuration, is used in a different sense, to avoid confusion, I have adopted the convenient word "areole." The

radial cell is indeed of older date than the Lepidoptera themselves, being present in fossil wings before that order existed.

From some form like *Xenogenes* arose the *Dichromodes* group, which is largely developed in Australia. *Dichromodes*, Figure 14, has R_2, R_3 and R_4 arising from the areole by a common stalk, and R_1 is closely applied to the areole, but does not anastomose with it. In *Epidesmia*, Figure 15, R_1 anastomoses strongly with the areole, forming a structure which is conveniently known as a "double areole." It would be more accurate to give this second accessory cell a distinct name, and I propose to call it the "pseudareole."* This forewing neuration is that characteristic of the family Larentiadae, Figure 16, where it is extremely constant, except that the pseudareole disappears by coalescence in many genera owing to the bases of R_1 and R_2 having become coincident.

We now proceed to consider the next largest group in the Australian fauna, the *Oenochroma* group. These consist of larger, stout-bodied moths, with the



Text-figs. 16-19.
16.—*Cidaria subochraria* Gn. 17.—*Oenochroma vinaria* Gn.
18.—*Arhodia lasiocamparia* Gn. 19.—*Eumelea rosalia* Stoll.

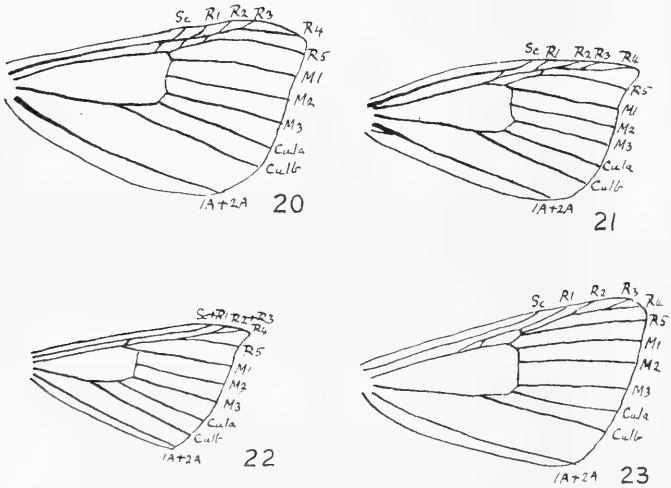
underside of the thorax densely hairy, all probably primitive characters. The neuration of *Oenochroma*, Figure 17, differs from that of *Xenogenes* essentially only in the extremely long and narrow areole, from which, however, R_2 arises separately. With this form of areole there is a strong tendency for the very short basal portion of R_3 to fail to chitinize, so that that vein is apparently "captured" by R_4, and the areole is lost by dissociation. This is illustrated by *Arhodia*, Figure 18, where R_2 and R_3 are even closer together than shown in the figure, but disconnected. That the difference between these two forms is of very little morphological importance, is shown by the fact that they may occur indiscriminately, not only in the same genus, but even in the same species.

* This word is indeed a hybrid, but it is very convenient.

The *Oenochroma* group consists of a number of small or monotypical genera, only two or three being of even moderate size. This points probably to its being a group of considerable age, which has undergone much loss in competition with more recently developed groups. It contains only one extra-Australian genus *Sarcinodes*, in which, as already noted, the hindwings are specialized.

There is another smaller group in which R_1 of the forewings anastomoses first with Sc and then with R_2. It is not a natural group like the two preceding, but contains several genera more or less allied. A simple example is the forewing of the very isolated genus *Eumelea*, Figure 19. Here the areole has been lost by disconnection of R_2 from R_3, as already explained, but there is a pseudareole. A very similar neuration is found in *Cernia* and is characteristic also of the Geometridae, and of many of the Boarmiadae. In *Encryphia*, Figure 20, the picture is more complicated; R_1 anastomoses with Sc and R_2, while the common stalk of R_2 and R_3 anastomoses with R_4, so that there are both areole and pseudareole as in *Epidesmia*. *Physetostege* and *Noreia* are allied, but in the former R_2 separates independently from the areole. In *Zeuctophlebia*, Figure 21, R_1 runs into Sc and there is no pseudareole.

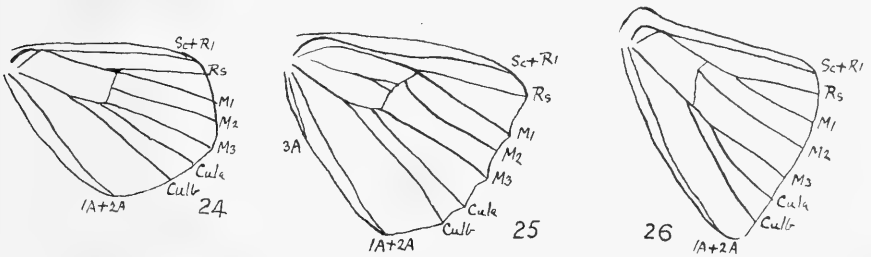
It is not necessary to discuss the neuration of every genus, but we must note the very distinct neuration of two extra-Australian genera, which have



Text-figs. 20-23.
20.—*Encryphia frontisignata* Wlk. 21.—*Zeuctophlebia squalidata* Wlk.
22.—*Derambila catherina* Prout. 23.—*Autanepsia poliodesma* Turn.

entered Queensland in recent geological time. They are *Derambila*, Figure 22, and *Ozola*. In the former R_1 runs into Sc immediately after its origin, and the areole has disappeared by coalescence, R_2 and R_4 being completely coincident. *Ozola* differs only in R_1 anastomosing first strongly with Sc and then with R_2. These genera exhibit a specialized line of development, which is quite unrepresented in the truly Australian genera, but one that may have originated from a form not very remote from the small *Encryphia* group.

In discussing the neuration of the Oenochromidae, we have incidentally shown how that characteristic of the Larentiadae, Geometridae and Boarmiadae may have developed. The only family remaining is the Sterrhidae. In a few genera of this family, *Organopoda*, *Rhodostrophia*, *Autanepsia*, Figure 23, a double areole is developed, which in the last-named genus is exactly similar to that in the *Taxeotis* group and in the Larentiadae (compare Figure 15 and Figure 16). The pseudareole in *Autanepsia* is small, and in the *Ptychopoda-Scopula* group, to which it belongs, has disappeared in most cases by the fusion of the bases of R_1 and R_2, leaving a single areole strictly comparable with that found in many Larentiadae. In *Organopoda* the areole is much smaller than the pseudareole, and in the *Anisodes* group the small accessory cell, which is usually present, is probably a



Text-figs. 24-26.
24.—*Scopula recessata* Wlk. 25.—*Protophyta castanea* Low.
26.—*Urolitha bipunctifera* Wlk.

pseudareole, the base of R_2 having fused with R_3. The opinion I expressed in my revision of the Sterrhidae (These Proceedings, 1907, p. 635) that this family originated from the Geometridae, I now consider erroneous, for in the latter family the areole is never developed, the distal dissociation of R_2 from R_3 by the loss of the basal origin of the latter having become a fixed character.* Certainly the structure of the forewing suggests a common origin of the Sterrhidae and Larentiadae from the Oenochromidae. At first sight, however, the structure of the hindwing, Figure 24, appears to negative such a supposition. Instead of a long approximation of Sc + R_1 to the cell, there is a short anastomosis near their bases followed by an immediate divergence. This is a constant character in the family, and is not found in any Oenochromid genus, so far as I know. A similar structure is, however, found in the Geometridae, where the most primitive genera, Figure 25, have the long approximation, while some of the most modified have the basal anastomosis and divergence, Figure 26. Every intermediate—gradual shortening of the approximation, gradual closer approximation near the base—can be traced in this family. There seems no reason why a parallel development should not have occurred in the Sterrhidae, though here, in the absence of intermediate forms, no direct evidence of it remains. Possibly, however, some might be obtained by a careful and detailed examination of the pupal tracheation.

Before proceeding to the systematic part of this paper I wish to acknowledge the generous assistance I have received by the loan of specimens from the South

* *Leucesthes* and *Mixochroa*, both without a frenulum and belonging to the least primitive section of the family, are exceptions. Here the presence of the anastomosis appears to be reversionary.

Australian Museum, the National Museum, Melbourne, Mr. Geo. Lyell, Mr. G. M. Goldfinch, and Mr. W. B. Barnard, by which this revision has been rendered much more complete than it otherwise could have been. I must also acknowledge Mr. L. B. Prout's kind help in determining the species of *Eumelea*, *Sarcinodes* and *Derambila*.

Family Oenochromidae.

Face smooth or with anterior tuft of scales, rarely with corneous prominence or process. Tongue well developed, very rarely absent. Labial palpi moderate or sometimes long. Thorax and abdomen slender and smooth, or stout with undersurface of thorax densely hairy. Posterior tibiae rarely without middle spurs, very rarely distorted in ♂ (*Celerena*). Female very rarely apterous. Forewings with areole usually present, sometimes double. Hindwings with R_1 rarely developed, subcostal with humeral curve or angle, usually closely approximated to cell as far as middle.

This family includes a number of subgroups, for the most part not clearly definable, comprising the more primitive genera of the Geometrites. It can hardly be defined positively, for it consists of the residuum left after the separation of Larentiadae, Sterrhidae, Geometridae, and Boarmiadae. I include here the Brephinae of Prout, separated by him on characters that I consider illusory, and all the groups referred by him to the Oenochromidae, though I think his revision contains a few genera which should be referred elsewhere.

Dirce Prout and *Xenomusa* Meyr., I refer to the Boarmiadae. In the former, vein 5 of the hindwings is absent, in the latter, if present at all, it is vestigial. *Diceratucha* Swin., which has no trace of a humeral curve or angle in the subcostal of the hindwing, belongs to the Notodontidae. It is nearly allied to *Gallaba* Wlk., with which it agrees in the structure of the tegulae, also in wing-shape and wing-pattern. The chitinous frontal process, which is exceptional in that family, occurs in the Noctuidae as well as the Oenochromidae and Boarmiadae. It is an adaptation to facilitate emergence from the pupal shell, and is most often found in genera inhabiting arid regions.

Key to Genera.

1. Forewings with 7, 8, 9 stalked, 10 absent 2
   Forewings with 10 present 3
2. Forewings with 11 running into 12; posterior tibiae without middle spurs ..... *Derambila* 43
   Forewings with 11 anastomosing with 12 and 10; posterior tibiae with a single median spur ..... *Ozola* 44
3. Forewings with 10 and 11 long-stalked 4
   Forewings with 10 and 11 separate at origin 9
4. Forewings with the common stalk of 10 and 11 anastomosing with 12 5
   Forewings with stalk of 10 and 11 not anastomosing with 12 7
5. Hindwings with 12 closely approximated to cell 6
   Hindwings with 12 well separated from cell ..... *Celerena* 36
6. Fore and hindwings with 5 from much above middle of cell ..... *Axiagasta* 37
   Fore and hindwings with 5 from middle of cell ..... *Zeuctophlebia* 39
7. Thorax and abdomen slender, the former not densely hairy beneath 8
   Thorax and abdomen stout, the former densely hairy beneath .. *Amphiclasta* 38
8. Forewings without areole; hindwings with 6 and 7 separate ..... *Systatica* 7
   Forewings with areole; hindwings with 6 and 7 stalked ..... *Satraparchis* 8
9. Forewings with 11 anastomosing with 12 and 10 10
   Forewings with 11 not anastomosing with 12 and 10 16

10. Forewings without areole 11
Forewings with areole 12
11. Forewings with 10 stalked with 7, 8, 9 ..... *Cernia* 34
Forewings with 10 from cell ..... *Eumelea* 35
12. Hindwings with 12 anastomosing with cell to middle ..... *Gerusia* 31
Hindwings with 12 not anastomosing with cell 13
13. Hindwings with 12 closely applied to cell from one-fourth to three-fourths ..... *Enchocrana* 19
Hindwings with 12 diverging from cell near base 14
14. Antennae of ♂ ciliated ..... *Noreia* 41
Antennae of ♂ bipectinate 15
15. Forewings of ♂ with a large sub-basal fovea ..... *Physetostege* 40
Forewings of ♂ without fovea ..... *Encryphia* 42
16. Forewings with areole present, not extremely long and narrow; thorax and abdomen slender, the former not or slightly hairy beneath 17
Forewings with areole extremely long and narrow or lost by disconnection of 10; thorax and abdomen usually stout, the former usually densely hairy beneath 28
17. Forewings with a double areole 18
Forewings with areole single 23
18. Hindwings with 12 approximated to cell to near its end 19
Hindwings with 12 diverging from cell about middle 20
19. Forewings with 12 free ..... *Nearcha* 1
Forewings with 12 connected by a bar with areole ..... *Antasia* 3
20. Antennae of ♂ unipectinate ..... *Epidesmia* 9
Antennae of ♂ simple or bipectinate 21
21. Antennae of ♂ simple or rarely very shortly pectinate ..... *Taxeotis* 2
Antennae of ♂ bipectinate, pectinations long 22
22. Forewings with 12 connected by a bar with areole ..... *Tapinogyna* 4
Forewings with 12 free ..... *Cathaemacta* 5
23. Forewings with 8, 9, 10 arising from areole by a common stalk 24
Forewings with 10 arising separately from areole ..... *Xenogenes* 15
24. Face with a strong anterior corneous projection ..... *Arcina* 10
Face smooth or with a short tuft of scales, without corneous projection 25
25. Forewings with raised tufts of scales 26
Forewings without raised scales 27
26. Palpi moderate; hindwings with 3 arising from nearer 4 than 2 .... *Bradyctena* 11
Palpi long; hindwings with 3 arising from midway between 2 and 4 ..... *Phrixocomes* 12
27. Antennae of ♂ unipectinate ..... *Dichromodes* 13
Antennae of ♂ bipectinate ..... *Adeixis* 14
28. Hindwings with 12 anastomosing with cell 29
Hindwings with 12 not anastomosing with cell 31
29. Forewings with 11 anastomosing with 12 30
Forewings with 11 free ..... *Macroctenia* 22
30. Posterior tibiae without middle spurs ..... *Dinophalus* 17
Posterior tibiae with middle spurs ..... *Lissomma* 18
31. Thorax with posterior crest 32
Thorax without crest 33
32. Antennae of ♂ unipectinate; palpi and its terminal joint moderate .. *Hypographa* 20
Antennae of ♂ bipectinate; palpi and its terminal joint long ..... *Carthaea* 27
33. Posterior tibiae without middle spurs 34
Posterior tibiae with middle spurs 35
34. Face with strong conical corneous projection ..... *Homospora* 30
Face smooth, not projecting ..... *Arhodia* 29
35. Thorax and abdomen slender, the former not or slightly hairy beneath 36
Thorax and abdomen moderate or stout, the former hairy beneath 37
36. Forewings without areole; antennae of ♂ unipectinate ..... *Ecphyas* 6
Forewings with areole; antennae of ♂ bipectinate ..... *Symphylistis* 16
37. Hindwings with 5 from close to upper angle of cell ..... *Sarcinodes* 21
Hindwings with 5 not from close to upper angle of cell 38

38. Hindwings with 5 from above middle of cell 39
Hindwings with 5 from middle of cell 41
39. Antennae of ♂ unipectinate ..... *Monoctenia* 23
Antennae of ♂ imparipectinate ..... *Antictenia* 26
Antennae of ♂ bipectinate 40
40. Hindwings with 6 and 7 stalked ..... *Gastrophora* 28
Hindwings with 6 and 7 not stalked ..... *Circopetes* 32
41. Antennae of ♂ unipectinate ..... *Oenochroma* 25
Antennae of ♂ bipectinate 42
42. Hindwings with 3 arising from midway between 2 and 4; 12 approximated to cell to three-fourths ..... *Phallaria* 24
Hindwings with 3 arising from nearer 4 than 2; 12 diverging from cell about middle ..... *Onychodes* 33

Genus 1. Nearcha.

Nearcha Meyr., Proc. Linn. Soc. N.S.W., 1889, 1152; Prout, *Gen. Insect.* Oenochrom., 29.

Type, *N. buffalaria* Gn.

Face usually with projecting cone of scales, or smooth with a slight anterior tuft on lower edge. Tongue present. Palpi moderate or long, porrect, thickened with more or less appressed or rough scales. Antennae of ♂ bipectinate, pectinations long and continued to apex. Thorax and abdomen slender; the former smooth or slightly hairy beneath. Femora smooth. Tarsi not spinulose or with minute spines on posterior pair only. Forewings with areole present, 11 anastomosing strongly to form a double areole, 12 free. Hindwings with 6 and 7 stalked, 12 approximated to cell throughout.

Easily recognized by the bipectinate ♂ antennae, stalking of 6 and 7 of hindwings, and approximation of 12 as far as end of cell. The secondary sexual characters should be carefully observed. I have redescribed the species, as there has been much confusion over some of them.

Key to Species.

1. Face blackish 2
Face ochreous-whitish or grey with strong anterior tuft 10
2. Palpi 3½ ..... *ursaria* 1
Palpi less than 3 3
3. Forewings with postmedian line more or less sinuate 4
Forewings with postmedian line rounded 9
4. Palpi nearly 3 ..... *protophaes* 8
Palpi 2½ 5
Palpi less than 2½ 6
5. Forewings with termen sinuate beneath apex ..... *tristificata* 4
Forewings with termen not sinuate ..... *dasyzona* 3
6. Forewings with postmedian line denticulate ..... *caronia* 9
Forewings with postmedian line not denticulate 7
7. Forewings with postmedian line outwardly bowed in middle ..... *aridaria* 6
Forewings with postmedian line only slightly sinuate 8
8. Forewings with postmedian line more or less ferruginous ..... *buffalaria* 5
Forewings with postmedian line not ferruginous ..... *benecristata* 2
9. Forewings reddish-ochreous-whitish ..... *ophla* 10
Forewings grey ..... *staurotis* 7
10. Hindwings with apex acute, termen straight ..... *curtaria* 13
Hindwings not so 11
11. Head and upper surface of palpi grey ..... *nullata* 11
Head and upper surface of palpi grey-whitish ..... *atyla* 12

This key will not be found always easy to apply. For specimens of the male sex the following will usually be more satisfactory.

Key Based on Secondary Sexual Characters of Male.

1. Hindwings with one or more tufts or ridges of fine hairs on under surface.. 2
   Hindwings without tufts or ridges beneath 9
2. Forewings with ridges of hairs on under surface ..... *ursaria* 1
   Forewings without raised hairs beneath 3
3. Abdomen with fan-like lateral tufts on middle segments ..... *benecristata* 2
   Abdomen without fan-like tufts 4
4. Hindwings with tuft of hair on posterior margin of cell ..... *dasyzona* 3
   Hindwings without tuft on posterior margin of cell 5
5. Hindwings with tuft of hair on anterior margin of cell about middle 6
   Hindwings without tuft on anterior margin of cell about middle 8
6. Hindwings with two long ridges of pale hairs extending from cell to termen ..... *nullata* 11
   Hindwings without such ridges 7
7. Hindwings with high ridge of hairs on posterior margin of distal half of cell ..... *tristificata* 4
   Hindwings without ridge of hairs on posterior margin of cell ..... *buffalaria* 5
8. Hindwings with ridge of whitish-ochreous hairs on stalk of veins 6 and 7 ..... *atyla* 12
   Hindwings with ridge of fuscous-grey hairs on stalk of veins 6 and 7 .. *aridaria* 6
9. Posterior tibiae more or less dilated with internal groove and tuft of hairs ..... *ophla* 10; *caronia* 9; *staurotis* 7
   Posterior tibiae not dilated, without groove and tuft .... *curtaria* 13; *pseudophaes* 8

1. Nearcha ursaria

Panagra ursaria Gn., *Lep.*, x, 129.—*Nearcha oxyptera* Low., *Trans. Roy. Soc. S. Aust.*, 1903, 188.

♂. 40-45 mm. Head whitish-grey; face blackish. Palpi 3½; blackish, base sharply white. Antennae whitish-grey; pectinations in ♂ 5. Thorax and abdomen whitish-grey. Legs grey; posterior pair whitish; posterior tibiae in ♂ dilated, with internal groove and tuft. Forewings triangular, costa nearly straight, apex acute and produced, termen sinuate, oblique; on underside with a dense high ridge of pale hairs on lower margin of cell, with smaller ridges on veins 2 to 6 towards their origin, vein 2 abruptly bent in middle; pale grey or whitish-ochreous-grey with slight fuscous irroration; first line indicated by three minute dots or absent; a median, subcostal, fuscous, pale-centred, discal dot, rarely absent; postmedian line from three-fourths costa to two-thirds dorsum, doubly sinuate, more or less suffusedly developed, fuscous often mixed with ferruginous, often obsolete towards costa; a terminal series of blackish dots; cilia ochreous-whitish or grey-whitish. Hindwings with termen nearly straight, apex and tornus rounded; on underside with a ridge of pale hairs on base of vein 12, dense tufts of dark hairs on anterior margin of cell at middle and end, a ridge of pale hairs on posterior margin of distal part of cell and extending beyond cell, a small dark tuft on vein 2 near base; colour, terminal dots, and cilia as forewings; markings obsolete, sometimes traces of a transverse median line.

♀. 36-39 mm. Similar to ♂ except for sexual characters. Forewings with discal dot obsolete; postmedian line paler, more ferruginous.

The ♂ is easily distinguished. In the ♀ stress must be laid on the rather long palpi (3½), and the acute and produced apex of forewings with sinuate termen.

Queensland: Caloundra, Brisbane, Stradbroke Is., Coolangatta, Toowoomba. New South Wales: Sydney. Victoria: Melbourne, Ballarat.

2. Nearcha benecristata.

Warr., *Novit. Zool.*, 1895, 83.

♂. 33-36 mm. Head whitish-grey; face blackish. Palpi 2; blackish, at base sharply white. Antennae whitish-grey; pectinations in ♂ 5. Thorax whitish-grey. Abdomen whitish-grey; in ♂ with two pairs of fan-like expansions of dark scales on lateral aspects about middle, terminal segments clothed with long pale hairs above. Legs grey; posterior pair whitish; posterior tibiae in ♂ dilated, with internal groove and tuft. Forewings triangular, costa straight, apex moderately pointed, termen moderately rounded, oblique; pale grey or whitish-grey with very few darker scales; first line represented by median and subdorsal fuscous dots; a median, subcostal, fuscous, pale-centred, discal dot; postmedian line faintly marked or obsolete towards costa, thickened or double and blackish towards dorsum, sinuate, without ferruginous tinge; sometimes a faintly indicated fuscous dentate subterminal line; a terminal series of minute dark fuscous dots; cilia pale grey. Hindwings with termen slightly rounded; on underside with a large dark tuft on anterior margin of cell about middle, and a smaller dark tuft at end, a pale ridge of hairs on posterior margin of distal half of cell, and a small tuft between veins 2 and 3 beyond middle; as forewings, but without markings, or with median transverse line only.

♀. 30-34 mm. Differs from ♂ not only in sexual characters, but also in the very slightly developed postmedian line of forewings without any thickening towards costa.

The ♂ is very distinct. For recognition of the ♀, reliance must be placed on the short palpi (2), pale colouring of forewings, and absence of any ferruginous tinge in postmedian line.

North Queensland: Thursday Is., Cape York, Herberton. Queensland: Caloundra, Brisbane, Stradbroke Is.

3. Nearcha dasyzona.

Taxeotis dasyzona Low., *Trans. Roy. Soc. S. Aust.*, 1903, 185.—*Nearcha agnata* Prout, *Novit. Zool.*, 1913, 389.

♂. 32-36 mm. Head whitish-grey; face blackish. Palpi 2½; blackish, base sharply white. Antennae pale grey; pectinations in ♂ 4. Thorax and abdomen pale grey with a few fuscous scales. Legs whitish irrorated with fuscous; anterior pair grey. Forewings triangular, costa nearly straight, apex pointed, termen slightly rounded, moderately oblique; pale grey with a few scattered fuscous scales; first line obsolete, or represented by median and subdorsal fuscous dots, occasionally also by subcostal and dorsal dots; a median, subcostal, fuscous, discal dot, sometimes pale-centred; postmedian line from three-fourths costa to two-thirds dorsum, often obsolete towards costa, rather strongly sinuate, consisting of a series of dark fuscous dots, followed by a fine pale line, and this by a usually fuscous line sometimes wholly or partly ferruginous, either the first or last of these components may be wholly or partly obsolete; no subterminal dots; a terminal series of blackish dots; cilia grey, apices paler. Hindwings with termen slightly rounded; colour, terminal dots, and cilia as forewings; markings obsolete, or with a faint median transverse line; underside with a fuscous tuft on anterior margin of cell about middle, an ochreous tuft on posterior margin opposite this, a dense ridge of ochreous hairs around end of cell, and a small ridge between veins 3 and 4 near origin.

♀. 30-38 mm. Palpi 2½. Similar to ♂, but postmedian line of forewings less strongly marked.

The ♂ cannot be mistaken if the sexual tufts on hindwings are noted. The ♀ may be distinguished by the length of palpi and form of forewing, but in the latter it comes so near *tristificata* that the distinction is difficult. Lower's type is a ♀.

South Australia: Hoyleton (type *dasyzona*). Victoria: Daytrap near Sea Lake (one ♂ in Coll. Lyell). Queensland: Charleville (1 ♀). Western Australia: Perth, Waroona, Dowerin.

4. Nearcha tristificata.

Tephrina tristificata Wlk., *Cat. Brit. Mus.*, xxiii, 967.—*Panagra transactaria* Wlk., *ibid.*, 999.—*Panagra resignata* Wlk., *ibid.*, 1003.—*Nearcha prosedra* Turn., *Trans. Roy. Soc. S. Aust.*, 1904, 226.

♂. 30-36 mm. Head grey; face blackish. Palpi 2½ to 2¾; blackish, base sharply white. Antennae grey; pectinations in ♂ 5. Thorax and abdomen grey. Legs grey; posterior pair whitish irrorated with grey; middle femora of ♂ with sub-basal and subapical tufts of hair; posterior tibiae of ♂ dilated, with internal groove and tuft. Forewings triangular, costa very slightly arched, apex acute and slightly produced, termen sinuate, oblique; grey sometimes with slight fuscous irroration; first line obsolete, or represented by three dark fuscous dots, which are sometimes preceded by a pale line; a median, subcostal, fuscous, usually pale-centred, discal spot; postmedian line from four-fifths costa to three-fourths dorsum, usually obsolete towards costa, strongly sinuate, represented by a series of dark fuscous dots, succeeded by a pale line, which is sometimes edged with a more or less suffused fuscous line, rarely any ferruginous tinge; no subterminal line; a terminal series of dark fuscous dots; cilia grey. Hindwings with termen gently rounded; on underside a large dense tuft on anterior margin of cell about middle, and a second smaller on end of cell, a ridge of hairs on posterior margin of distal half of cell; grey; usually a fine, dark, slightly curved, median, transverse line, followed by a pale line, but one or both may be obsolete; terminal dots and cilia as forewings.

♀. 29-34 mm. Palpi 2½ to 2¾. Forewings with fuscous dots of postmedian line usually absent, very small when present, but pale following line always present, and sometimes with a darker posterior suffused edge.

Though nearly allied to *buffalaria*, the ♂ is easily distinguished. In the ♀ reliance must be placed on the grey colouring without ochreous tinge, the slightly longer palpi, and the usual absence of any ferruginous tinge in postmedian line.

Queensland: Caloundra, Stradbroke Is., Southport, Coolangatta, Toowoomba, Dalby. New South Wales: Sydney, National Park, Jervis Bay, Katoomba.

5. Nearcha buffalaria.

Panagra buffalaria Gn., *Lep.*, x, 128.

♂. 33-37 mm. Head pale-ochreous-grey; face blackish. Palpi 2 to 2¼; blackish, base sharply white. Antennae grey-whitish; pectinations in ♂ 4. Thorax and abdomen pale grey, more or less ochreous-tinged. Legs ochreous-whitish irrorated with grey; anterior pair grey; middle femora fringed with long hairs throughout; posterior tibiae dilated with internal groove and tuft. Forewings triangular, costa nearly straight, apex acute, termen gently rounded, moderately oblique; pale grey more or less ochreous-tinged with slight darker irroration; costal edge pale

brownish-ochreous; first line represented by two or three dark fuscous dots; a median, subcostal, fuscous, pale-centred, discal spot; postmedian line from four-fifths costa to three-fourths dorsum, sometimes obsolete on costa, sinuate, represented by a series of dark fuscous dots, followed by a pale line, and this by a fuscous-ferruginous line, occasionally the fuscous dots or the pale line not developed; usually a subterminal series of suffused fuscous dots or spots, sometimes very distinct; a terminal series of blackish dots; cilia pale ochreous-grey. Hindwings with termen gently rounded; underside with dark tufts on anterior edge of cell about middle and end, no ridge of scales on posterior edge of cell; colour as forewings; sometimes without markings, but usually with a fine, fuscous, transverse, median line.

♀. 32-36 mm. Palpi 2 to 2½. Forewings with apex slightly produced; first line obsolete; discal spot faintly marked, rarely obsolete; postmedian line without dark fuscous dots, ferruginous suffusion usually well marked.

There is no doubt that Guenée's description refers to this species, but Meyrick's (Proc. Linn. Soc. N.S.W., 1889, 1154) is based on a confusion of several species.

North Queensland: Cairns, Herberton. Queensland: Gympie, Brisbane, Toowoomba, Warwick, Stanthorpe. New South Wales: Ebor, Port Macquarie.

6. Nearcha aridaria.

Tephrina aridaria Wlk., *Cat. Brit. Mus.*, xxxv, 1662.—*Nearcha aridaria* Meyr., Proc. Linn. Soc. N.S.W., 1889, 1155.

♂. 24-32 mm. Head whitish-grey; face blackish. Palpi 2; blackish, base sharply white. Antennae whitish-grey; pectinations in ♂ 5. Thorax and abdomen pale grey. Legs pale grey; posterior pair whitish with fuscous irroration; posterior tibiae dilated, with internal groove and tuft. Forewings triangular, costa straight, slightly arched towards apex, apex acute, termen slightly rounded, moderately oblique; pale grey, with fine sparse darker irroration; first line from one-third costa to one-third dorsum, sometimes continuous, but usually reduced to a variable number of dots; a median, subdorsal, fuscous, usually pale-centred, discal dot or spot; postmedian line from two-thirds costa to two-thirds dorsum, sinuate, upper part strongly bowed outwards, sometimes continuous, usually reduced to a series of fuscous dots variably developed, sometimes followed by a fine ferruginous line; sometimes some very indistinct subterminal spots; sometimes a series of blackish terminal dots; cilia pale grey. Hindwings with termen gently rounded; on underside a tuft of dark hairs on stalk of veins 6 and 7; colour, terminal dots, and cilia as forewings; discal dot usually obsolete above, but distinct beneath; a fine median transverse line slightly developed, or obsolete.

♀. 30-32 mm. Palpi 2¼. Wings a darker grey; markings ill-defined; postmedian line may be absent.

Apart from the characters of the ♂, this species may be distinguished by the short palpi, uniform grey irroration, and strongly bowed postmedian line.

Queensland: Duaringa, Clermont, Warwick. New South Wales: Murrurundi, National Park, Bathurst. Victoria: Sea Lake.

7. Nearcha staurotis.

Meyr., Proc. Linn. Soc. N.S.W., 1889, 1153.—*Nearcha nephrocrossa* Turn., *Trans. Roy. Soc. S. Aust.*, 1904, 227.—*Nearcha recisa* Prout, *Gen. Insect.* Oenochrom., p. 30.

♂. Eastern Australian examples 26-36 mm.; Western Australian examples

30-40 mm. Head grey-whitish; face blackish. Palpi 2 to 2¼; blackish, base sharply white. Antennae grey-whitish; pectinations grey, very long (8). Thorax, abdomen and legs pale grey; posterior tibiae slightly dilated with internal groove. Forewings triangular, costa very slightly arched, apex pointed, termen slightly rounded, slightly oblique; pale grey; first line from one-fourth costa to one-third dorsum, represented by three or four fuscous dots, rarely connected, sometimes partly ferruginous, rarely obsolete; a median, subdorsal, fuscous, usually pale-centred, discal dot or spot; postmedian line from two-thirds costa to two-thirds dorsum, outwardly rounded, not or scarcely sinuate, represented by a series of dark fuscous dots, rarely connected, followed by a pale line, and this sometimes by a fuscous suffusion, which may be rather broad with a crenulate outer edge, occasionally partly ferruginous; a terminal series of blackish dots; cilia pale grey. Hindwings with termen rounded; colour, terminal dots, and cilia as forewings; a fine fuscous median transverse line or series of dots, sometimes followed by a whitish line.

♀. Eastern Australian examples 30-34 mm.; Western Australian examples 36 mm. Similar to ♂, but markings usually less defined.

This species is variable both in markings and size. Specimens from Cape York are unusually small; those from Western Australia often large.

N. nephrocrossa is a unique aberration with lines almost wholly whitish, and a pale terminal band with crenulate inner edge. One ♂ from Cape York has the two lines connected by blackish streaks; another from Herberton has the markings nearly obsolete.

North Queensland: Prince of Wales Island, Thursday Island, Cape York, Herberton. Queensland: Bundaberg, Brisbane, Mt. Tambourine, Coolangatta, Warwick, Stanthorpe. New South Wales: Lismore, Tabulam. Western Australia: Perth, Waroona, Bridgetown, Yallingup, Geraldton.

8. Nearcha pseudophaes.

Low., *Trans. Roy. Soc. S. Aust.*, 1893, 155.—*Nearcha uncta* Prout, *Novit. Zool.*, 1913, 389.

♂. 30-35 mm. Head ochreous-whitish, sometimes pale grey; face blackish. Palpi 2½ to 2¾ blackish, base sharply white. Antennae ochreous-whitish; pectinations grey, very long (10). Thorax and abdomen pale grey or grey. Legs pale grey; posterior tibiae not dilated. Forewings triangular, costa straight, or slightly sinuate, gently arched towards apex, apex pointed, termen gently rounded, slightly oblique; pale grey or grey, sometimes with darker irroration; first line from one-fourth costa to one-third dorsum, represented by three or four blackish dots preceded by a pale line; a median, subcostal, fuscous, usually pale-centred, discal spot; postmedian line from three-fourths costa to three-fourths dorsum, sinuate, usually obsolete towards costa, represented by a series of blackish dots, each edged posteriorly with whitish, succeeded usually by a ferruginous line; sometimes a suffused pale subterminal line; a terminal series of blackish dots; cilia pale grey or grey. Hindwings with apex and tornus rounded, termen nearly straight; pale grey; terminal dots and cilia as forewings.

Variable; in one example in Coll. Lyell the blackish dots on both lines of forewing have disappeared and are replaced by whitish dots; this form has been described as *uncta* Prout.

Victoria: Blackrock near Melbourne. South Australia: Mt. Lofty. Western Australia: Perth, Kelmscott.

9. NEARCHA CARONIA.

Swin., *Trans. Ent. Soc.*, 1902, 641.

♂ ♀. 26-28 mm. Head grey-whitish. Palpi 1⅔; dark fuscous, lower surface sharply white. Antennae grey-whitish; pectinations in ♂ 10, grey. Thorax and abdomen pale grey. Legs pale grey; posterior pair grey-whitish. Forewings triangular, costa straight nearly to apex, apex round-pointed, termen slightly rounded, oblique; pale grey sparsely irrorated with dark fuscous; markings dark fuscous; a short erect mark on one-third dorsum, sometimes obsolete, sometimes followed by a median dot; a small pale-centred discal spot beneath midcosta; a finely denticulate sinuate line from three-fourths costa to two-thirds termen, suffusedly edged with whitish posteriorly, sometimes nearly obsolete; a terminal series of dots; cilia pale grey. Hindwings with termen gently rounded; without tufts or raised scales beneath in ♂; as forewings but with no trace of first line. Underside similar but paler and less defined.

Allied to *N. staurotis* and *N. ophla*. It is considerably smaller and has shorter palpi than the former, and with the postmedian line starting from three-fourths and not two-thirds costa, and differently formed. The latter has a whiter head, forewings rather more elongate, with more curvature in the termen, and often develops a subterminal crenulate whitish line. All three species are variable.

North Australia: Darwin (Swinhoe's type). North-west Australia: Parry and Queen Islands (J. J. Walker); a series including the type in the British Museum.

10. NEARCHA OPHLA.

Swin., *Ann. Mag. Nat. Hist.* (7), ix, 1902, 79; Prout, *Gen. Insect.*, Oenochrom., Pl. 1, f. 15.—*Nearcha pseudophaes* Warr., *Novit. Zool.*, 1902, 349, *nec* Lower.—*Nearcha anemodes* Low., *Trans. Roy. Soc. S. Aust.*, 1902, 227.—*Nearcha pyrosema* Low,. *ibid.*, 1903, 188.

♂. 28-30 mm. ♀. 27-34 mm. Head ochreous-whitish; face blackish. Palpi 1½; blackish, base sharply white. Antennae ochreous-whitish; pectinations in ♂ grey, very long (10). Thorax and abdomen whitish-ochreous, sometimes tinged with reddish. Legs ochreous-whitish; anterior pair pale grey; posterior tibiae in ♂ dilated with internal groove and tuft. Forewings triangular, costa straight almost to apex, apex pointed, termen slightly rounded, slightly oblique; whitish-ochreous, often reddish tinged, with sparse fuscous irroration; first line obsolete or faintly represented, sometimes reddish; a median, subdorsal, fuscous, pale-centred, discal dot; postmedian from two-thirds costa to two-thirds dorsum, continuous or dotted, fuscous or reddish, sometimes obsolete; sometimes a pale crenulate subterminal line; a terminal series of blackish dots; cilia ochreous-whitish. Hindwings with termen gently rounded; colour, terminal dots, and cilia as forewings; a discal dot and curved transverse median line sometimes present.

A desert form, the pale, often reddish, colouring being protective.

North Australia: Tennant's Creek. North-west Australia: Derby, Onslow, Roeburne, Sherlock River.

11. NEARCHA NULLATA.

Panagra nullata Gn., *Lep.*, x, 130.—*Panagra subcelata* Wlk., *Cat. Brit. Mus.*, xxiii, 997.—*Nearcha subcelata* Meyr., PROC. LINN. SOC. N.S.W., 1889, 1157.

♂. 30-34 mm. Head grey; face with strong anterior tuft. Palpi 4½; grey. Antennae grey-whitish; pectinations 4. Thorax grey. Abdomen whitish-grey. Legs grey; posterior pair whitish with some darker scales. Forewings triangular,

costa gently arched, apex acute and slightly produced, termen slightly sinuate, oblique; grey-whitish sometimes with slight fuscous irroration; first line from one-fifth costa to one-third dorsum, represented by three or four dark fuscous dots, rarely obsolete; a subcostal, fuscous, pale-centred, discal dot rather before middle, rarely obsolete; postmedian line from four-fifths costa to two-thirds dorsum, nearly straight or slightly sinuate, represented by a series of dark fuscous dots, often pale-edged posteriorly, sometimes followed by a suffused median dark fuscous spot, rarely by a suffused line; a terminal series of blackish dots; cilia grey-whitish. Hindwings with termen rounded; on under side a very strong tuft of dark hairs on anterior margin of cell about middle, and two lines of long pale hairs, first from cell to apex, second from cell to termen on vein 6; colour, terminal dots, and cilia as forewings; sometimes with traces of a transverse median line.

♀. 26-34 mm. Palpi 5. Forewings with first line nearly or quite obsolete; discal dot often obsolete; postmedian line with dots minute or obsolete, succeeded by a pale line, and this by a suffused grey line.

Easily distinguished from all species except the next. Guenée's description agrees very well, assuming that his type is a ♀.

Queensland: Brisbane, Stradbroke Is., Coolangatta, Toowoomba. New South Wales: Newcastle, Sydney, Jervis Bay, Katoomba, Bathurst. Victoria: Beaconsfield, Warragul, Gisborne, Dunkeld.

12. Nearcha atyla.

Meyr., Proc. Linn. Soc. N.S.W., 1889, 1157.

♂. 33-36 mm. Head grey-whitish; face with a strong anterior tuft. Palpi 4; grey, upper surface grey-whitish. Antennae pale grey; pectinations 5. Thorax and abdomen whitish-grey. Legs grey; posterior pair grey-whitish; posterior tibiae dilated with internal groove and tuft. Forewings triangular, costa gently arched, apex acute and slightly produced, termen slightly sinuate, oblique; grey-whitish sometimes with slight fuscous irroration; first line from one-fifth costa to one-third dorsum, represented by three or four dark fuscous dots; a subcostal, fuscous, pale-centred discal dot rather before middle; postmedian line from four-fifths costa to two-thirds dorsum, nearly straight; represented by a series of dark fuscous dots, sometimes followed by a pale line, and this by a dark fuscous suffused median spot, but this is not always developed; a terminal series of blackish dots; cilia grey-whitish. Hindwings with termen rounded; on underside a short ridge of pale hairs on anterior margin of terminal end of cell extending on to the stalk of veins 6 and 7; pale grey; a terminal series of blackish dots; cilia pale grey.

♀. 34-36 mm. Palpi 4½. Forewings with first line nearly or quite obsolete; discal dot very faint; postmedian line with dots minute or absent, followed by a pale slightly ferruginous line, and this by a suffused grey line.

Very similar to *N. nullata*. The ♂ is readily distinguished; the ♀ may be known by the shorter palpi and whiter head and upper surface of palpi.

Western Australia: Perth, Waroona, Busselton, Albany.

13. Nearcha curtaria.

Panagra curtaria Gn., *Lep.*, x, 129.—*Panagra corrogata* Wlk., *Cat. Brit. Mus.*, xxiii, 997.—*Nearcha curtaria* Meyr., Proc. Linn. Soc. N.S.W., 1889, 1158.

♂. 34-38 mm. Head ochreous-whitish; face with strong anterior tuft. Palpi 4½; fuscous, upper surface ochreous-whitish, base beneath sharply white. Antennae

grey-whitish; pectinations grey, rather long (6). Thorax and abdomen ochreous-whitish. Legs grey; posterior pair whitish with a few grey scales; posterior tibiae not dilated, without internal groove. Forewings triangular, costa gently arched, apex acute and slightly produced, termen nearly straight, oblique; ochreous-whitish with sparse fuscous irroration; first line from one-fourth costa to one-third dorsum, usually represented by three or four dark fuscous dots, rarely continuous; a median, subcostal, fuscous, pale-centred, discal dot; second line from three-fourths costa to two-thirds dorsum, sinuate, usually represented by a series of dark fuscous dots, rarely continuous and suffused, succeeded by a pale line, and this by a fuscous or fuscous-ferruginous line, sometimes reduced to a series of dots; a more or less developed, pale fuscous, subterminal line or series of spots, usually indistinct; a terminal series of blackish dots; cilia ochreous-whitish. Hindwings with termen straight, apex rather acutely pointed, tornus rounded-rectangular; whitish-grey; terminal dots and cilia as forewings.

♀. 34-38 mm. Palpi 4½ to 5. Forewings with markings less distinct, rarely obsolete.

Easily recognized by the peculiar shape of hindwings.

New South Wales: Sydney, Mt. Kosciusko (5,000 feet). Victoria: Melbourne, Beaconsfield. Tasmania: Hobart, Russell Falls, Georgetown, Launceston, Ulverstone, Strahan.

Genus 2. Taxeotis.

Meyr., Proc. Linn. Soc. N.S.W., 1889, 1140; Prout, *Gen. Insect.*, Oenochrom., p. 33.

Type, *T. intextata* Gn. (*nec* Meyr.).

Face smooth. Tongue present. Palpi moderate or rather long, porrect, thickened with more or less appressed or rough scales. Antennae of ♂ usually more or less distinctly laminate, sometimes almost simple, and shortly ciliated, rarely with longer cilia arising in tufts, or even from very short pectinations. Thorax and abdomen slender; the former not hairy beneath. Femora smooth. Tarsi not spinulose. Forewings with areole present, 11 anastomosing strongly to form a double areole, 12 anastomosing at a point with areole, or connected with it by a cross-bar, or free. Hindwings with 6 and 7 usually separate at origin, 7 arising from shortly before angle, but sometimes connate from angle, 12 approximated to cell to about middle, thence gradually diverging.

A natural genus. The presence or absence of a connection between the subcostal vein and the areole is usually, but not always, a constant specific character. As Meyrick remarks, the species are commonly very difficult to distinguish, being obscurely coloured, extremely similar, and at the same time variable. For these reasons an artificial key would be more likely to mislead than to help. I have found it necessary to redescribe all the species, and have indicated their distinctive characters. Particular attention should be given to the shape of the forewings, the form of the postmedian line, the length of the palpi, and the coloration of face and palpi. By the last character the species may be conveniently divided into groups.

1. Palpi blackish or dark fuscous with a sharply defined, clear white, basal area: *intextata*, *phricocyma*, *blechra*, *adelia*, *anthracopa*, *subvelaria*, *ochrosticta*, *epigypsa*.

2. Palpi dark fuscous or ferruginous-fuscous, basal area more or less white, but not sharply defined or not clear white: *egenata, perlinearia, bigeminata, philodora.*

3. Palpi dark fuscous or blackish, sometimes ferruginous-fuscous: *acrothecta, oraula, goniogramma, holoscia, xanthogramma, eremophila, alloceros, orphnina, epigaea, compar, isomeris.*

4. Palpi pale-ferruginous, sometimes white at base: *phaeopa, exsectaria, mimela, stereospila, endela, aenigmatodes.*

5. Palpi with upper surface whitish: *exaereta.*

The first three species, all described by Meyrick, I have not seen.

14. Taxeotis philodora.

Meyr., Proc. Linn. Soc. N.S.W., 1889, 1151.

Differs from all other species by the absence of a discal dot on forewings.

Western Australia: Carnarvon.

15. Taxeotis epigypsa.

Meyr., Proc. Linn. Soc. N.S.W., 1889, 1149.

Something like *T. intermixtaria*, but with shorter palpi, forewings ochreous-whitish, with large black terminal dots.

South Australia: Quorn.

16. Taxeotis isomeris.

Meyr., Proc. Linn. Soc. N.S.W., 1889, 1144.

Distinguished by the presence of two triangular black costal spots on forewing.

Western Australia: Albany.

17. Taxeotis intextata.

Panagra intextata Gn., *Lepid.*, x, 130.—*Panagra inconcisata* Wlk., *Cat. Brit. Mus.*, xxiii, 1003.—*Taxeotis delogramma* Meyr., Proc. Linn. Soc. N.S.W., 1889, 1146.

♂. 24-30 mm. ♀. 24-28 mm. Head grey; face blackish. Palpi 1¾ to 2; blackish with a sharply defined white basal area. Antennae ochreous-grey-whitish becoming darker grey towards apex, basal half more or less annulated with dark fuscous; in ♂ shortly but distinctly laminate and shortly ciliated (½). Thorax and abdomen grey, occasionally with some dark fuscous irroration. Legs ochreous-grey-whitish irrorated with dark fuscous. Forewings triangular, costa nearly straight, apex acute and similar in both sexes, termen slightly sinuate, slightly oblique; 12 anastomosing at a point with areole (20 ♂, 7 ♀), or connected with areole by a cross-bar (47 ♂, 26 ♀); pale grey, in ♀ usually darker grey, with more or less fuscous irroration, which is often more pronounced on costa; first line from one-fourth costa to one-fourth dorsum, usually represented by three fuscous dots, costal, median, and subdorsal, sometimes by a more or less complete fuscous line, sometimes obsolete, usually so in ♀; a distinct, blackish, median, subcostal, discal dot; postmedian line from three-fourths costa, fuscous, very distinct on costa, often incomplete beneath costa, forming a moderately acute angle beneath costa, but this is often indistinct or undeveloped, thence doubly sinuate to three-fourths dorsum, excurved in middle, more or less ferruginous, and usually dotted with fuscous, sometimes closely followed by a fuscous line; a subterminal series of fuscous dots closely follows postmedian line, paired dots

above middle and above dorsum often enlarged; a terminal series of blackish dots well marked in ♂, less so or obsolete in ♀; cilia pale grey, a broad subbasal fuscous line usually very distinct, but occasionally absent. Hindwings with termen well rounded; as forewings, but without first line; postmedian line variably developed, sometimes reduced to a series of dots; subterminal line of dots indistinct or obsolete.

The most common and widely distributed species in the Eastern States. I have seen none from Western Australia. It is characterized by the acute apices of forewings, sinuate termen, pale grey coloration of ♂, usually ferruginous tinged postmedian line, which is angled beneath costa, thence doubly sinuate, and the conspicuous line in cilia, which last is, however, not invariable.

The name *intextata* was applied by Meyrick to the same species as *perlinearia* Wlk. Guenée's description does not seem to me to apply to that species and agrees better with *inconcisata*, but so doubtfully that I was inclined to regard his name as unidentifiable. The publication of a figure of Guenée's type by Oberthür (*Etudes Lep. Comp.*, xx, 1923) supports the latter identification. I have not indeed been able to see this figure, but accept Mr. L. B. Prout's judgment conveyed to me by letter.

Queensland: Duaringa, Caloundra, Brisbane, Stradbroke Island, Mt. Tambourine, Toowoomba, Dalby, Bunya Mts., Warwick, Stanthorpe. New South Wales: Glen Innes, Sydney, Katoomba, Mt. Wilson, Bathurst, Jenolan, Jervis Bay, Moruya. Victoria: Beechworth, Melbourne, Beaconsfield, Sale, Gisborne, Castlemaine, Dunkeld. Tasmania: Launceston, Deloraine, St. Helen's, Hobart. South Australia: Mt. Lofty. (? Western Australia: Albany, York.)

18. Taxeotis phricocyma, n. sp.

φρικοκυμος, with rippled wave.

♂. 21-23 mm. Head pale grey; face dark fuscous tinged with ferruginous. Palpi 2; dark fuscous sometimes tinged with ferruginous; beneath sharply white except at apex. Antennae grey or grey-whitish; in ♂ simple, very shortly ciliated. Thorax pale grey. Abdomen grey-whitish with a few fuscous scales. Legs grey-whitish; coxae and femora irrorated with fuscous. Forewings rather broadly triangular, costa very slightly arched, apex rather acutely pointed, termen slightly rounded, slightly oblique; 12 connected with areole by a cross-bar (5 ♂); whitish with sparsely scattered blackish scales and a few pale grey, transverse strigulae; first line fuscous, from one-fourth costa to one-fourth dorsum, straight, rather broadly suffused, interrupted, or reduced to three dots; a median, subcostal, dark fuscous, discal dot; postmedian line from three-fourths costa, slender, interrupted, twice waved outwards, first beneath costa, then below middle, thence curved inwards to three-fourths dorsum, sometimes partly double, sometimes ferruginous-tinged; a subterminal series of fuscous dots sometimes faintly indicated; a terminal series of blackish dots, usually conspicuous; cilia whitish mixed with grey, which tends to form two faint lines. Hindwings with termen rounded; without first line and discal dot; second line double, but developed only towards dorsum.

A small species with peculiarly formed postmedian line.

Western Australia: Bunbury, Perth, Busselton in October; five specimens received from Mr. L. J. Newman.

19. TAXEOTIS BLECHRA, n. sp.

βληχρος, feeble.

♂. 20-22 mm. ♀. 19-23 mm. Head grey; face blackish. Palpi 1½; blackish with a sharply defined white basal area. Antennae grey with some dark fuscous annulations towards base; in ♂ very slightly laminate, almost simple, minutely ciliated (¼). Thorax and abdomen grey. Legs fuscous; posterior pair grey-whitish with some fuscous irroration. Forewings triangular, costa very slightly arched, apex pointed but not acute, termen slightly rounded, slightly oblique; 12 anastomosing at a point with areole (1 ♂, 1 ♀), or connected with it by a bar (4 ♂); grey with a very few fuscous scales; costa sometimes strigulated with fuscous; first line represented by a fuscous costal dot at one-third, and median and subdorsal dots at one-fourth; a median, subcostal, fuscous, discal dot; postmedian line from a fuscous costal dot at two-thirds, usually disconnected, but, if developed, angled beneath costa, thence nearly straight or very slightly sinuate to three-fourths dorsum, usually reduced to a series of dots; a subterminal series of suffused fuscous dots sometimes developed; a terminal series of blackish dots; cilia grey, irrorated with fuscous except at apices. Hindwings with termen rounded; as forewings, but without first line; postmedian line curved, usually indistinct.

Smaller than *T. intextata*, with postmedian line almost straight, simple, and not ferruginous, and different antennal structure. *T. adelia* differs in the absence of costal and subterminal dots and the well defined continuous lines of forewing. In one example a whitish costal dot precedes first line and another follows postmedian line.

Western Australia: Kalamunda near Perth in December, Waroona in January; nine specimens received from Mr. W. B. Barnard.

20. TAXEOTIS ADELIA.

Prout, *Gen. Insect.*, Oenochrom., p. 35.

♂. 22-23 mm. ♀. 20-23 mm. Head grey or grey-whitish; face blackish. Palpi 2; blackish with a sharply defined basal white area. Antennae pale grey; in ♂ almost simple, very shortly ciliated. Legs pale grey, posterior pair whitish, with some fuscous irroration. Forewings triangular, costa straight, gently arched towards apex, apex pointed but not acute, termen gently rounded, slightly oblique; 12 anastomosing at a point with areole (1 ♀), or connected with it by a cross-bar (2 ♂, 1 ♀); pale grey with a few scattered fuscous scales; first line from one-fourth costa to one-fourth dorsum, slender, fuscous, sometimes incomplete or interrupted; a median, subcostal, dark fuscous, discal dot, larger in ♂; postmedian line slender, fuscous, from three-fourths costa, curved outwards, then angled and continued as a nearly straight, very slightly sinuate line to three-fourths dorsum; no subterminal line of dots; an interrupted, dark fuscous, terminal line, or series of dots; cilia pale grey with some fuscous irroration, sometimes a distinct postmedian fuscous line. Hindwings with termen rounded; as forewings, but without first line; postmedian line almost straight, becoming obsolete towards costa.

My material of this species is small, but sufficient to establish its distinctness. It is near *T. inconcisata*, but smaller, apex of forewings not acute, postmedian line simple and almost straight (in the latter it is rather strongly bisinuate), subterminal line obsolete. Mr. Prout describes the markings as ferruginous, and his examples apparently showed more strongly lined cilia.

Victoria: Gisborne in February; four specimens received from Mr. Geo. Lyell. I have also seen a ♀ (18 mm., in Coll. Lyell) from Daytrap near Sea Lake, Victoria, and 2 ♂, 1 ♀ (18-20 mm., W. H. Matthews and W. B. Barnard) from Perth, Western Australia, all of which I refer to this species.

21. Taxeotis anthracopa.

Meyr., Proc. Linn. Soc. N.S.W., 1889, 1145.—? *Taxeotis pelopa* Meyr., *Trans. Ent. Soc. Lond.*, 1897, 377.

♂. 23-28 mm. ♀. 25-28 mm. Head grey, sometimes ochreous-whitish anteriorly; face blackish. Palpi 1½; blackish, sharply white towards base beneath. Antennae with basal third whitish or ochreous-whitish annulated with fuscous, thence grey; in ♂ very slightly laminate, shortly ciliated. Thorax, abdomen, and legs grey. Forewings triangular, costa in ♂ slightly and evenly arched, in ♀ nearly straight, apex pointed, more acute in ♀, termen slightly rounded, slightly oblique; 12 anastomosing at a point with areole (5 ♂, 3 ♀), or connected by a cross-bar (26 ♂, 6 ♀); pale grey, very sparsely irrorated with darker grey; costal edge usually narrowly ochreous; first line usually indicated by a median and a subdorsal fuscous dot, sometimes obsolete; a fuscous, median, subcostal, discal dot; postmedian represented by a series of fuscous dots from four-fifths costa to two-thirds dorsum, at first outwardly curved, then sinuate, rarely a connected line, in ♀ sometimes nearly obsolete, very rarely with a trace of ferruginous coloration; a faint subterminal series of dots sometimes developed in ♂, rarely larger and distinct, sometimes obsolete, usually obsolete in ♀; an interrupted blackish terminal line or series of dots; cilia pale grey. Hindwings with termen rounded; as forewings, but without basal line; discal dot present; subterminal dots rarely developed.

Differs from *T. intextata* in the more uniform grey coloration, usually ochreous-edged costa, differently formed postmedian line, which is rounded, not angled, beneath costa, and the much simpler postmedian markings, together with absence of any line in cilia.

Queensland: Caloundra, Brisbane, Stradbroke Island, Southport, Coolangatta, Toowoomba, Stanthorpe. New South Wales: Sydney, Jervis Bay, Katoomba, Mt. Wilson, Mittagong. Victoria: Melbourne, Beaconsfield, Gembrook, Castlemaine. Tasmania: Deloraine, Hobart.

22. Taxeotis intermixtaria.

Panagra intermixtaria Wlk., *Cat. Brit. Mus.*, xxiii, 1000.—*Panagra promelanaria* Wlk., *ibid.*, xxvi, 1666.—*Taxeotis intermixtaria* Meyr., Proc. Linn. Soc. N.S.W., 1889, 1149.

♂. 26-32 mm. ♀. 25-26 mm. Head ochreous-grey-whitish; face dark fuscous. Palpi in ♂ 2½, in ♀ 3; dark fuscous, beneath white except at apex, sharply defined. Antennae pale grey; in ♂ slightly laminate, shortly ciliated. Thorax and abdomen pale grey. Legs grey. Forewings triangular, costa slightly and evenly arched, apex moderately pointed, not acute, termen moderately rounded, slightly oblique; 12 anastomosing at a point with areole (3 ♂, 2 ♀), or connected with areole by a cross-bar (5 ♂, 2 ♀); pale grey very sparsely irrorated with fuscous scales, rather more so in ♀; a fuscous dot above dorsum at one-third, another in disc at one-fourth, and sometimes another on costa at one-third, representing first line; a small, median, subcostal, fuscous, discal dot; a fuscous dot on costa at three-fourths,

giving rise to a slightly sinuate line of similar dots to dorsum at two-thirds, but sometimes disconnected from it; subterminal line of dots usually absent, but sometimes partly developed; a terminal series of blackish dots; cilia grey-whitish with a darker median line. Hindwings with termen rounded; as forewings, but without first line; postmedian line rounded, faintly marked or obsolete.

I have not seen many of this species, but sufficient to show that the absence of a subterminal line is not invariable. The markings stand out very distinctly on a pale grey background, and it is a neater species than *T. anthracopa*, from which it may be distinguished by the longer palpi as well as absence of ochreous edge on costa.

New South Wales: Bathurst. Victoria: Melbourne, Beaconsfield, Gisborne.

23. Taxeotis subvelaria.

Panagra subvelaria Wlk., *Cat. Brit. Mus.*, xxiii, 1000.—*Panagra reserata* Wlk., *ibid.*, 1010.—*Taxeotis isophanes* Meyr., Proc. Linn. Soc. N.S.W., 1889, 1150.—*Taxeotis subvelaria* Prout, *Gen. Insect.*, Oenochrom., Pl. i, f. 11.

♂. 28-33 mm. ♀. 26-30 mm. Head grey; face blackish. Palpi 2 to 2¼; blackish, sharply white towards base beneath. Antennae pale grey; in ♂ shortly laminate and moderately ciliated. Thorax and abdomen grey. Legs fuscous; posterior pair whitish or grey irrorated with fuscous. Forewings triangular, costa gently and evenly arched in both sexes, apex pointed, not acute, termen gently rounded, scarcely oblique; 12 anastomosing at a point with areole (6 ♂, 4 ♀) or connected by a cross-bar (24 ♂, 18 ♀); grey with a few scattered dark fuscous scales; first line nearly straight from one-third costa to one-third dorsum, usually reduced to 3 or 4 fuscous dots, occasionally obsolete in ♀; a fuscous, median, subcostal, discal dot; postmedian line from four-fifths costa to two-thirds dorsum, sinuate, consisting of a series of fuscous dots, sometimes partly connected, occasionally these dots are very slightly ferruginous posteriorly; a subterminal line of dots variably developed, occasionally obsolete; a terminal series of blackish dots; cilia grey. Hindwings with termen rounded; pale grey; usually a faint fuscous transverse line or series of dots beyond middle, only slightly rounded; terminal dots often minute; cilia grey.

A good distinguishing mark of this species is the absence of the discal dot of the hindwings, which is, however, present on the underside. Very rarely is it faintly indicated on the upper surface. The palpi are longer than in *T. anthracopa*, and the costa of forewings is not ochreous tinged.

Queensland: Stanthorpe. New South Wales: Glen Innes, Armidale, Murrurundi, Sydney, Katoomba, Moruya, Cooma, Adaminaby, Broken Hill. Victoria: Melbourne, Beaconsfield, Gisborne, Castlemaine, Dunkeld. Tasmania: Launceston, Hobart. South Australia: Mt. Lofty.

24. Taxeotis ochrosticta, n. sp.

ὠχροστικτος, pale spotted.

♂. 26-28 mm. ♀. 26-28 mm. Head grey; face blackish. Palpi 1½; blackish with a sharply defined white basal area. Antennae grey, in ♂ shortly laminate, shortly ciliated. Thorax and abdomen grey. Legs grey, posterior pair whitish, with slight fuscous irroration. Forewings triangular, costa straight, slightly arched near base and apex, apex pointed but not acute, termen gently rounded, slightly oblique; 12 anastomosing at a point with areole (2 ♂, 1 ♀, left forewing only), or connected by a cross-bar (4 ♂, 2 ♀), or free (the same ♀ right forewing); grey

with very slight fine, fuscous irroration, rather more in ♀; first line incomplete and twice dentate, represented by median and subdorsal dots, or absent; a median, subcostal, fuscous, discal dot; postmedian line represented by a line of ochreous-whitish dots parallel to termen; a terminal series of minute dark fuscous dots; cilia pale grey with more or less fine ochreous-whitish irroration. Hindwings with termen rounded; as forewings, but subterminal pale dots developed towards dorsum only.

Very distinct by the postmedian series of whitish-ochreous dots of forewing.

Queensland: Duaringa in September; nine specimens received from Mr. W. B. Barnard.

25. Taxeotis egenata.

Panagra egenata Wlk., *Cat. Brit. Mus.*, xxiii, 997.—*Taxeotis egenata* Meyr., Proc. Linn. Soc. N.S.W., 1889, 1148.

♂. 30-35 mm. ♀. 32-35 mm. Head grey; face blackish. Palpi 1½ to 1⅔; blackish with a whitish basal area sharply defined, but not clear white and containing some fuscous irroration. Antennae grey; in ♂ slightly laminate, shortly ciliated. Thorax and abdomen grey. Legs grey with some fuscous irroration. Forewings triangular, costa straight, slightly arched towards apex, apex acute and slightly produced; termen very slightly sinuate; 12 anastomosing at a point with areole (2 ♂), or connected with it by a cross-bar (7 ♂, 5 ♀); grey with a few scattered dark fuscous scales; second line from one-fourth costa to one-fourth dorsum, nearly straight but rarely developed, sometimes represented by two or three fuscous dots, more often obsolete; a median, subcostal, fuscous discal dot, usually minute, rarely obsolete; postmedian from four-fifths costa to two-thirds dorsum, rather strongly rounded beneath costa, but not angled, thence straight or slightly sinuate; fuscous and distinct, or reduced to a series of fuscous dots, rarely obsolete, immediately followed by a whitish-ochreous or ferruginous line, which may be edged posteriorly with fuscous, so that postmedian line appears double; a subterminal series of fuscous dots variably developed, sometimes blackish with the two subdorsal dots enlarged; cilia grey, apices paler, sometimes with a distinct line of demarcation. Hindwings with termen rounded; as forewings, but without basal line and similarly variable.

This is a winter species, not difficult to recognize by the wing-shape and rather peculiar palpi; in the former it resembles *T. perlinearia.*

North Queensland: Stannary Hills near Herberton. Queensland: Rockhampton, Duaringa, Emerald in September, Peak Downs in July, Gayndah in July, Brisbane in July, August and September, Stradbroke Island, Toowoomba in July and August, Dalby.

26. Taxeotis perlinearia.

Panagra perlinearia Wlk., *Cat. Brit. Mus.*, xxiii, 998.—*Panagra areniferata* Wlk., *ibid.*, 998.—*Panagra explicataria* Wlk., *ibid.*, 998.—*Taxeotis intextata* Meyr., Proc. Linn. Soc. N.S.W., 1890, 1147 (*nec* Guenée).—*Nearcha didymochroa* Low., *Trans. Roy. Soc. S. Aust.*, 1894, 80.—*Taxeotis collineata* Warr., *Novit. Zool.*, 1899, 13.—? *Taxeotis semifusca* Warr., *ibid.*, 324.

♂. 30-36 mm. ♀. 30-36 mm. Head grey; face ferruginous-fuscous. Palpi in ♂ 1½, in ♀ 1½ to 1⅔; ferruginous-fuscous, rather paler than face, toward base whitish, but basal area not clear white nor sharply defined. Antennae whitish-grey; in ♂ laminate and moderately ciliated. Thorax grey, sometimes brownish, with a few blackish scales. Abdomen grey with a few blackish scales. Legs

grey, posterior pair whitish, all with more or less dark fuscous irroration. Forewings triangular, costa very slightly arched or nearly straight, apex acute, often very slightly produced, more so in ♀, termen very slightly rounded, moderately oblique; 12 anastomosing at a point with areole (4 ♂, 3 ♀), or connected with areole by a short cross-bar (19 ♂, 14 ♀), or free (2 ♀); pale grey or whitish-grey with a very variable amount of fuscous irroration; in ♀ darker and more brownish-tinged; costal edge before middle usually narrowly ochreous; first line from three-fourths costa to three-fourths dorsum, usually represented by three fuscous or ferruginous-fuscous dots, sometimes obsolete, sometimes a more or less distinct suffused line, rarely clearly defined with three short projections outwards, beneath costa, in middle, and above dorsum; a median fuscous discal dot towards costa; postmedian line from three-fourths costa, curved outwards, then acutely angled inwards and sinuate to three-fourths dorsum, but often incomplete or obsolete towards costa so that the acute angle is not developed, beneath angle usually ferruginous, often with dark fuscous dots, it is also often double beneath angle; a subterminal series of fuscous dots succeeds the postmedian line very closely, often conspicuous, sometimes minute and partly obsolete; a terminal series of blackish dots; cilia grey, bases often irrorated with dark fuscous. Hindwings with termen gently rounded; as forewings, but without first line; postmedian line similarly variably developed.

Though very variable this species may be easily recognized by the short ferruginous-fuscous palpi, with whitish ill-defined basal area together with the rather long and narrow forewings with acute slightly produced apices. Corroborative points are the ochreous costal edge of forewings, and the ferruginous, peculiarly angled postmedian lines, but these are not constant. All forms of the species are taken together. The type is an example of one of the less common forms in which the lines are very sharply and completely developed.

North Queensland: Charters Towers (Warren). Queensland: Duaringa, Nambour, Brisbane, Stradbroke Island, Mt. Tambourine, Toowoomba, Stanthorpe. New South Wales: Sydney, Jervis Bay. Victoria: Melbourne, Beaconsfield, Leongatha, Moe, Gisborne. South Australia: Mt. Lofty.

27. Taxeotis acrothecta.

Turn., *Trans. Roy. Soc. S. Aust.*, 1904, 223.

♂. 23-27 mm. ♀. 26 mm. Head whitish-grey; face dark ferruginous-fuscous. Palpi 1¼; dark ferruginous-fuscous. Antennae grey-whitish; in ♂ slightly laminate, shortly ciliated. Thorax and abdomen whitish-grey. Legs grey; posterior pair whitish. Forewings triangular, costa straight, slightly arched towards base and apex, apex acute, slightly produced, termen sinuate, oblique; 12 anastomosing with areole (3 ♂), or connected with it by a bar (1 ♂, 1 ♀); grey-whitish, brownish-tinged in ♀, with sparse fuscous irroration; first line in ♀ straight from one-fourth dorsum nearly to one-fourth costa, in ♂ represented by subdorsal and median fuscous dots; a median, subcostal, fuscous, discal dot; postmedian from four-fifths costa, obtusely angled beneath costa, but often disconnected above angle, thence sinuate to three-fourths dorsum, in ♂ reduced to a series of fuscous dots, in ♀ entire, followed by a pale ferruginous line; a subterminal line of fuscous dots, usually mostly obsolete, closely follows; a terminal series of dark fuscous dots, cilia grey-whitish. Hindwings with termen rounded; as forewings, but without first line; postmedian line evenly curved.

Distinguished by the wholly dark palpi together with the rather narrow forewings with acutely produced apices, and from *T. oraula* by the absence of fuscous costal spots.

North Queensland: Townsville, Magnetic Island; in August and September.

28. Taxeotis oraula.

Meyr., Proc. Linn. Soc. N.S.W., 1889, 1143.—*Taxeotis adelpha* Turn., *Trans. Roy. Soc. S. Aust.*, 1904, 224.

♂. 20-28 mm. ♀. 24-28 mm. Head grey-whitish; face blackish. Palpi in ♂ 1½, in ♀ 2; blackish. Antennae grey, towards base grey-whitish; in ♂ slightly laminate; very shortly ciliated. Thorax and abdomen pale grey with slight fuscous irroration. Legs grey, posterior pair whitish, with more or less fuscous irroration. Forewings triangular, costa nearly straight, slightly arched near base and apex, less so in ♀, apex in ♂ rather acutely pointed, in ♀ acute and slightly produced, termen slightly sinuate, moderately oblique; 12 anastomosing at a point with areole (3 ♂, in one instance on one side only), or free but usually closely approximated (14 ♂, 4 ♀); pale grey with more or less fuscous irroration; first line straight, from one-third costa to one-third dorsum, represented by a fuscous costal spot and fuscous median and subdorsal dots rarely connected, in ♀ sometimes obsolete; a median, subcostal, fuscous, discal dot; postmedian line arising from a second fuscous costal spot at two-thirds, angled acutely inwards beneath costa, but upper limb of angle rarely developed, thence rather strongly bisinuate to two-thirds dorsum, ferruginous, interrupted in ♂ by fuscous or blackish dots, followed by a pale line, which is usually edged posteriorly by fuscous, so that postmedian line appears double; a subterminal series of fuscous dots, pale edged posteriorly, variably developed, sometimes well marked, sometimes obsolete; a terminal series of blackish dots; cilia grey, bases mixed with fuscous, which sometimes forms an indistinct line. Hindwings with termen rounded; as forewings, but without first line; second line usually developed only towards dorsum.

Very similar to *T. intextata*, but much smaller and the palpi wholly blackish; the costal spots are usually well developed.

New South Wales: Barrington Tops (4,000-5,000 feet), Katoomba (3,500 feet), Mt. Kosciusko (5,000-6,000 feet). Victoria: Gisborne. Tasmania: Russell Falls, Beaconsfield, Cradle Mt. (2,000-3,000 feet), Burnie, Zeehan, Strahan.

29. Taxeotis goniogramma.

Meyr., *Trans. Ent. Soc. Lond.*, 1897, 376.

♂. 28 mm. Head grey; face blackish. Palpi 1½; blackish. Antennae pale grey; in ♂ slightly laminate, shortly ciliated. Thorax and abdomen grey. Legs grey; posterior pair grey-whitish. Forewings triangular, costa very slightly arched, apex acute, termen slightly sinuate, slightly oblique; 12 connected by a bar with areole (1 ♂); grey rather densely irrorated with fuscous, less so towards costa and termen; first line obsolete; a median, subcostal, fuscous, discal dot slightly indicated; postmedian line from three-fourths costa to two-thirds dorsum, pale suffusedly edged with fuscous on both sides, forming a right angle beneath costa; a subterminal series of blackish dots slightly developed; a slender oblique fuscous streak from beneath apex; an interrupted blackish terminal line; cilia grey-whitish with a few fuscous points. Hindwings with termen rounded; as forewings, but paler; discal dot obsolete; postmedian line median, nearly straight, pale, edged on both sides with fuscous.

Queensland: Toowoomba in May; one specimen received from Mr. W. B. Barnard. I have little doubt, allowing for variation, that this is conspecific with Meyrick's type from Duaringa.

30. Taxeotis holoscia.

Low., *Trans. Roy. Soc. S. Aust.*, 1903, 186.

♂. 26-31 mm. ♀. 24-31 mm. Head grey; face blackish. Palpi 1½; wholly blackish. Antennae grey, bases paler and sometimes annulated with fuscous; in ♂ laminate and shortly ciliated. Thorax and abdomen grey. Legs fuscous; posterior pair grey. Forewings triangular, costa slightly and evenly arched, apex rather acutely pointed, termen slightly rounded, slightly oblique; 12 anastomosing with areole at a point (3 ♂), or connected with it by a cross-bar (7 ♂, 7 ♀); rather dark grey with a few scattered fuscous scales; first line nearly straight, from one-fourth costa to one-third dorsum, usually reduced to subdorsal and median fuscous dots; a median, subcostal, blackish, discal dot; postmedian line from three-fourths costa gently curved outwards, then slightly sinuate to two-thirds dorsum, usually reduced to a series of fuscous dots, occasionally ferruginous, occasionally edged posteriorly by ochreous-whitish; subterminal line obsolete or very faintly indicated; a terminal series of blackish dots, sometimes minute; cilia grey, apices paler. Hindwings with termen rounded; as forewings, but without first line; discal dot distinct or obsolete; postmedian line evenly curved, sometimes scarcely developed or only towards dorsum.

Very similar to *T. anthracopa* and *T. subvelaria*, but immediately distinguished by the wholly blackish palpi.

Queensland: Brisbane, Stradbroke Island, Toowoomba; seventeen specimens, all taken in September or early in October.

31. Taxeotis xanthogramma.

Low., *Trans. Roy. Soc. S. Aust.*, 1903, 186.

♂. 25-32 mm. ♀. 22-26 mm. Head whitish-grey; face blackish. Palpi 2 to 2½; blackish. Antennae grey; in ♂ dentate, ciliations 1. Thorax pale grey. abdomen grey. Legs fuscous; posterior pair grey. Forewings triangular, in ♂ broad, costa moderately and evenly arched, apex round-pointed in ♂, pointed but not acute in ♀, termen rounded, slightly oblique; 12 connected by a bar with areole (6 ♂, 1 ♀); pale grey, sparsely irrorated with fuscous; first line from one-third costa to one-third dorsum, nearly straight, consisting of costal, median, and dorsal fuscous spots, each edged anteriorly more or less with ferruginous; a median, subcostal, fuscous, discal dot; postmedian line from two-thirds costa, broadly outwardly curved, and then sinuate to two-thirds dorsum, composed of fuscous dots edged posteriorly more or less with ferruginous; a sinuate subterminal series of fuscous dots more or less developed; a terminal series of blackish dots; cilia grey more or less mixed with grey-whitish. Hindwings with termen rounded; grey, darker than forewings; without markings, except for some fuscous strigulae on dorsum; terminal dots present or absent; cilia grey.

Easily recognized by the conspicuous lines of ferruginous-edged dots, and the broad forewings with rounded apices of the ♂.

New South Wales: Broken Hill. Victoria: Birchip, Sea Lake. South Australia: Pinnaroo.

32. Taxeotis bigeminata.

Prout, *Gen. Insect.*, Oenochrominae, p. 35.

♂. 19 mm. Head brown-whitish; face dark fuscous. Palpi 2; dark fuscous, lower surface towards base brown-whitish. Antennae brownish; ciliations in ♂ $\frac{2}{3}$. Thorax brownish. Abdomen brown-whitish. Legs fuscous-brown; posterior pair brown-whitish. Forewings triangular, costa gently arched, apex round-pointed, termen bowed, oblique; 11 connected with 12; brown-whitish; markings dark fuscous; a double oblique line from one-third costa to one-fourth dorsum, the posterior line obsolete towards costa; a median subcostal discal dot; a second double line from two-thirds costa, bent outwards beneath costa, then sharply angled parallel to termen and doubly toothed, upper tooth tolerably acute, lower obtuse, then sinuate to three-fourths dorsum, the posterior line obsolete towards costa; a terminal series of dots; cilia concolorous. Hindwings with termen rounded; brown-whitish; a minute median fuscous dot; a short double transverse line from three-fourths dorsum; a terminal series of dots; cilia concolorous. Underside brown-whitish, slightly darker in forewings, with sparse fuscous irroration, and a median dot in hindwings.

N.W. Australia: Sherlock River; described from the type in the British Museum.

33. Taxeotis eremophila, n. sp.

ἐρημοφιλος, a desert lover.

♂. 26 mm. Head grey-whitish; face blackish. Palpi $1\frac{3}{4}$; blackish. Antennae grey-whitish; in ♂ slightly dentate, ciliations 1. Thorax and abdomen grey-whitish. Legs fuscous; posterior pair grey. Forewings triangular, costa nearly straight to near apex, apex round-pointed, termen gently rounded, slightly oblique; 12 connected by a bar with areole; grey-whitish irrorated with fuscous; markings fuscous; antemedian line represented by two or three dots; a median subcostal discal dot; postmedian line slender, from three-fourths costa slightly outwardly oblique to middle of disc, thence twice angled, thence concave to two-thirds termen; in a second example the whole of the median area between the lines is uniformly suffused with fuscous; a subterminal series of suffused dots; a terminal series of blackish dots; cilia grey-whitish. Hindwings with termen gently rounded; pale grey; a few subterminal fuscous dots towards dorsum; a terminal series of fuscous dots; cilia pale grey. Underside uniformly pale grey.

Nearest *T. xanthogramma*, which it resembles in shape of wing, but with the lines much less distinctly marked, without any ferruginous tinge, and the ground-colour much whiter.

South Australia: Ooldea (A. J. Nicholson) in August; two specimens in Coll. Goldfinch.

34. Taxeotis phaeopa.

Low., Proc. Linn. Soc. N.S.W., 1899, 84.

♂. 25-31 mm. ♀. 24 mm. Head grey-whitish; face pale ferruginous. Palpi in ♂ 2, in ♀ $2\frac{1}{2}$; pale ferruginous. Antennae grey; in ♂ slightly laminate with moderate ciliations. Thorax grey-whitish. Abdomen pale grey. Legs grey; posterior pair whitish. Forewings triangular, costa arched at base, thence straight to near apex, apex pointed but not acute, termen slightly rounded, scarcely oblique; 12 connected by a bar with areole (5 ♂, 3 ♀); whitish sparsely irrorated with grey, and in ♀ with ferruginous; first line from a fuscous spot on one-third

costa, consisting of two ferruginous dots, median and subdorsal, sometimes partly connected and slightly outwardly dentate, in ♀ obsolete except costal spot; a median, subcostal, transversely elongate, fuscous, discal dot, sometimes minute in ♀; postmedian from a fuscous spot on two-thirds costa, thence extremely fine, crenulate, ferruginous, sometimes reduced to dots, obsolete in ♀, doubly sinuate to three-fourths dorsum; a subterminal series of fuscous dots more or less developed, sometimes obsolete; a terminal series of blackish dots; cilia whitish, bases sometimes ferruginous, sometimes slightly irrorated with grey. Hindwings with termen rounded; colour, terminal dots, and cilia as forewings; rarely with a median discal dot.

Among the species with pale ferruginous face and palpi this is distinguished by its whitish forewings, with lines very slender or obsolete, but with rather conspicuous costal spots.

New South Wales: Broken Hill.

35. Taxeotis exsectaria.

Panagra exsectaria Wlk., *Cat. Brit. Mus.*, xxiii, 1011.—*Taxeotis exsectaria* Meyr., Proc. Linn. Soc. N.S.W., 1889, 1144.—*Taxeotis calypsis* Prout, *Gen. Insect.*, Oenochrom., p. 35 (ab.).

♂. 18-26 mm. ♀. 18-22 mm. Head pale grey (rarely whitish), face ferruginous. Palpi in ♂ 2½, in ♀ 3; ferruginous with a white basal area. Antennae grey, towards base paler or whitish with some darker annulations; in ♂ slightly laminate, shortly ciliated (½). Thorax and abdomen grey. Legs fuscous with more or less whitish irroration. Forewings triangular, costa gently arched, apex rather acutely pointed, termen slightly sinuate, oblique; 12 anastomosing at a point with areole (1 ♂, 1 ♀), or connected with it by a bar (19 ♂, 10 ♀); pale grey; first line consisting of costal, median, subdorsal, and dorsal fuscous dots, often confluent toward dorsum, forming a short line; a median, subcostal, fuscous, discal dot; postmedian line consists of a fuscous dot on two-thirds costa, rarely connected with a bisinuate blackish or partly ferruginous line to two-thirds dorsum, sometimes reduced to a series of dots, this is followed by a pale line, sometimes followed by a fuscous suffusion so that postmedian line appears double; a subterminal series of fuscous dots, edged posteriorly with whitish, more or less developed; a terminal series of blackish dots; cilia pale grey. Hindwings with termen rounded; pale grey; discal dot obscure or absent; postmedian line slender, or developed towards dorsum only.

A variable species, always recognizable by its palpi. Western Australian specimens are rather larger, more uniformly grey, lines less intensely developed, etc., but the differences are not absolute and indicate only a local race (*eugenestera* Prout in Seitz's Macrolepidoptera).

I have examined the type of *T. calypsis*.

Queensland: Stradbroke Island, Coolangatta, Stanthorpe. New South Wales: Lismore, Sydney, Jervis Bay, Bathurst, Broken Hill. South Australia: Adelaide. Western Australia: Albany, Perth, Waroona, York, Collie.

36. Taxeotis mimela.

Prout, *Gen. Insect.*, Oenochrom., p. 36.

♂. 25-30 mm. ♀. 24-28 mm. Head ochreous-grey-whitish; face ferruginous or ferruginous-fuscous. Palpi in ♂ 1¼ to 2½, in ♀ 2½; ferruginous or ferruginous-

fuscous, sometimes paler towards base. Antennae ochreous-grey-whitish; in ♂ slightly laminate, shortly ciliated. Thorax, abdomen, and legs ochreous-grey-whitish with some scattered grey or fuscous scales. Forewings triangular, costa gently and evenly arched, less so in ♀, apex in ♂ rather acutely pointed, in ♀ acute and slightly produced, termen in ♂ gently rounded, in ♀ slightly sinuate, scarcely oblique; 12 free (7 ♂, 6 ♀), but often closely approximated to areole; ochreous-grey-whitish, in ♀ brownish-tinged, sparsely irrorated with pale fuscous; first line straight, from one-third costa to one-third dorsum, in ♂ reduced to 3 or 4 fuscous dots, in ♀ obsolete; a median, subcostal, fuscous, discal dot, usually minute, sometimes obsolete in ♀, rarely enlarged (1 ♂); postmedian line from a fuscous spot on two-thirds costa, at first outwardly oblique and then angled inwards beneath costa, but upper limb of angle usually obsolete, thence bisinuate, rather strongly so in ♂, less strongly in ♀, ending on two-thirds dorsum, this is followed by a pale line, which may be edged posteriorly with fuscous, so that postmedian appears double; subterminal line of dots well marked in ♂, pale-edged posteriorly, that above dorsum enlarged, in ♀ feebly marked or obsolete; cilia ochreous-whitish, bases partly or wholly grey, dividing line sometimes distinct. Hindwings with termen rounded; as forewings, but without first line; sometimes a pale crenulate subterminal line, but subterminal fuscous dots indistinct.

Generally resembling *T. intextata*, but at once distinguished by the very different palpi which, however, vary both in length and colour more than is usual in the genus. The dot-like discal spot of forewing distinguishes it from *T. stereospila*.

Queensland: Toowoomba, in December. New South Wales: Jenolan, in February. Victoria: Melbourne, Lorne, Beaconsfield, Moe, Leongatha, Gisborne, Mt. St. Bernard; from November to March.

37. Taxeotis exaereta, n. sp.

ἐξαιρετος, picked out.

♂. 20-23 mm. Head whitish or pale grey; face pale ferruginous. Palpi 2¼; fuscous; upper surface whitish. Antennae pale grey becoming whitish towards base; in ♂ slightly laminate, shortly ciliated. Thorax grey. Abdomen grey-whitish. Legs grey; posterior pair whitish. Forewings rather narrowly triangular, costa slightly arched, apex rather acutely pointed, termen slightly rounded, oblique; 12 free (3 ♂); grey-whitish or pale grey; markings fuscous; first line nearly straight from one-third costa to one-third dorsum, sometimes partly or wholly obsolete; a roughly circular, pale-centred, median, subcostal, discal spot; postmedian line from beneath three-fourths costa to two-thirds dorsum, strongly bisinuate, linear or reduced to a series of dots; a parallel subterminal series of dots more or less developed; a terminal series of dots; cilia grey-whitish. Hindwings slightly rounded; grey-whitish; without discal dot; postmedian line indicated only towards dorsum.

Differs from all other species in the palpi being whitish above, dark beneath, a reversal of the usual coloration. This, with the pale ferruginous face, makes it easy of recognition. In the pale-centred discal spot of forewings it agrees with *T. stereospila*.

Western Australia: Busselton, in October; three specimens received from Mr. G. M. Goldfinch, who has the type.

38. Taxeotis stereospila.

Meyr., Proc. Linn. Soc. N.S.W., 1889, 1142.

♂. 25-32 mm. ♀. 24-28 mm. Head ochreous-grey-whitish; face ferruginous. Palpi in ♂ 3 to 3½, in ♀ 3½ to 4; pale ferruginous. Antennae pale grey becoming ochreous-whitish towards base; in ♂ laminate, shortly ciliated. Thorax, abdomen and legs ochreous-grey-whitish, more or less irrorated with fuscous. Forewings triangular, costa gently and evenly arched, less so in ♀, apex acute, in ♀ slightly produced, termen slightly rounded, in ♀ slightly sinuate, slightly oblique; 12 free (19 ♂, 9 ♀), but sometimes rather closely approximated to areole; ochreous-grey-whitish, in ♀ often brownish, more or less irrorated with fuscous; costal edge ochreous, in ♂ often reddish-orange, towards base; first line nearly straight, from one-fourth costa to one-fourth dorsum, represented by three or four fuscous dots, that on costa often enlarged, rarely obsolete in ♂, more often in ♀; a small, median, subcostal, fuscous, discal spot with pale centre; postmedian line represented by a fuscous dot on three-fourths costa, not always present, and a disconnected line, sometimes connected by a fuscous streak with apex, from beneath costa near apex to two-thirds dorsum, sinuate, composed of fuscous or ferruginous dots sometimes connected, towards dorsum sometimes suffused or double, less often so in disc; a subterminal line of fuscous dots more or less developed closely follows; a terminal series of blackish dots; cilia ochreous-whitish, sometimes with basal fuscous irroration, which rarely in ♂, but often in ♀, is so dense as to form a distinct line. Hindwings with termen rounded; concolorous; discal dot usually obsolete, when present nearly always minute, never pale-centred; postmedian line usually developed only towards dorsum; terminal dots and cilia as forewings.

Differs from all except the preceding in the pale-centred discal spot of forewing. From *T. adelia*, to which it is allied, it differs also in the longer palpi and ochreous costa.

Queensland: National Park (2,500 feet), Toowoomba, Bunya Mt. (3,500 feet), Warwick, Killarney, Stanthorpe. New South Wales: Sydney, Mt. Wilson (3,500 feet), Bathurst. Victoria: Gisborne, Mansfield.

39. Taxeotis endela.

Meyr., Proc. Linn. Soc. N.S.W., 1889, 1142.—*Prototypa dryina* Turn., *ibid.*, 1916, 252.

♂. 27-32 mm. ♀. 24-32 mm. Head ochreous-whitish, face pale ferruginous. Palpi 2; pale ferruginous, sometimes suffusedly whitish at base. Antennae grey-whitish; in ♂ strongly laminate with rather long ciliations. Thorax, abdomen, and legs ochreous-whitish. Forewings triangular, costa nearly straight except near base and apex, apex pointed, in ♀ acute, termen slightly sinuate, slightly oblique; 12 free but closely approximated to 11 before it joins areole (4 ♂, 2 ♀), or anastomosing with 11 (3 ♂, 1 ♀); ochreous-whitish; first line usually obsolete, sometimes represented by subdorsal and median fuscous dots at one-third; a median, subcostal, fuscous, discal dot, sometimes obsolete (1 ♂, 3 ♀); postmedian line straight or nearly so, from two-thirds dorsum to beneath five-sixths costa, represented by fine fuscous dots, sometimes connected by a ferruginous line, but sometimes obsolete; a fine fuscous terminal line, sometimes interrupted or reduced to dots; cilia ochreous-whitish. Hindwings with termen rounded; ochreous-grey-whitish; sometimes a discal dot; no postmedian line; terminal line and cilia as forewings.

Distinguished by its ochreous-whitish colour and straight postmedian line not connected with costa, and the pale ferruginous underside of wings without markings.

New South Wales: Glen Innes, Ebor, Bathurst, Mittagong. Victoria: Melbourne, Beaconsfield.

40. Taxeotis aenigmatodes, n. sp.

αἰνιγματωδης, obscure, puzzling.

♀. 24-25 mm. Head grey-whitish; face pale ferruginous. Palpi 2½; pale ferruginous, towards base whitish. Antennae grey-whitish. Thorax pale grey. Abdomen whitish with some grey irroration. Legs grey-whitish; anterior pair pale grey. Forewings triangular, costa straight, except near base and apex, apex acutely pointed, termen slightly rounded, slightly oblique; 12 free; whitish rather sparsely, but uniformly irrorated with grey; first line indicated by very obscure median and subdorsal dots; discal dot obsolete; second line pale ferruginous, straight, oblique, from two-thirds dorsum to beneath three-fourths costa; a suffused whitish subterminal line; a fine fuscous terminal line; cilia grey-whitish, with indications of a darker median line. Hindwings with termen only slightly rounded; as forewings, but postmedian and subterminal lines obscure. Underside uniform pale ochreous-grey.

Perhaps allied to *T. endela*, but in the absence of the ♂ its generic position is not quite certain.

New South Wales: Ebor, in January; two specimens.

41. Taxeotis alloceros, n. sp.

ἀλλοκερως, with different antennae.

♂. 30-36 mm. Head grey; face ferruginous-fuscous. Palpi 1¼; ferruginous-fuscous. Antennae grey; very shortly bipectinate (1) almost to apex, the pectinations ending in short ciliations. Thorax grey, sometimes brownish-tinged. Abdomen similar, with a few fuscous scales. Legs fuscous; posterior pair whitish irrorated with fuscous. Forewings triangular, costa moderately and evenly arched, apex acute, slightly produced, termen slightly sinuate, oblique; 12 free (12 ♂); pale grey, sometimes brownish-tinged, sparsely irrorated with dark-fuscous; first line represented by from one to three fuscous dots, median, subdorsal, and dorsal, and by a larger, dark fuscous, oblique spot on costa at one-third; a median, subcostal, dark fuscous, discal dot; postmedian represented by a second oblique dark fuscous spot on costa at two-thirds, and by a disconnected, strongly bisinuate, line of dark fuscous dots, rarely complete and acutely angled line from costa, this is succeeded by a pale line suffusedly edged with fuscous posteriorly, so that postmedian line appears double; there follows closely a subterminal series of dark fuscous dots, pale-edged posteriorly, variably developed, the dorsal spot of the series being larger and blackish; a terminal series of blackish dots; cilia grey-brown irrorated with fuscous, apices paler. Hindwings with termen rounded; as forewings, but without first line; postmedian line strongly bowed in middle.

♀. 32-34 mm. Similar to ♂, but browner and darker in colour. Forewings with 12 free (8 ♀); first line suffused and continuous when developed, and preceded by a pale line; these do not reach first costal spot; postmedian formed by two continuous fuscous lines separated by a conspicuous whitish-ochreous line, all rather sharply angled inwards beneath costa, thence bisinuate to three-fourths dorsum; subterminal slightly developed or obsolete.

A very distinct species. The antennal structure of the ♂ is peculiar in the genus, and approaches that of *Antasia*, which differs in the stalking of 6 and 7 of hindwings. In all other respects *alloceros* agrees with *Taxeotis* and is closely related to other species of the genus.

North Queensland: Eungella (2,500 feet) in October. Queensland: Eidsvold in September, Toowoomba (only in rain forest), in September and October, Killarney in November; twenty specimens. New South Wales: Lismore.

42. TAXEOTIS ORPHNINA.

Turn., *Trans. Roy. Soc. S. Aust.*, 1904, 224.

♂. 23 mm. ♀. 24 mm. Head pale grey; face dark-fuscous. Palpi 1¼; dark-fuscous. Antennae pale grey; in ♂ laminated and biciliated in tufts, cilia long (2). Thorax, abdomen and legs grey. Forewings triangular, costa very slightly arched, in ♀ sinuate, apex rather acutely pointed, in ♀ acute and slightly produced, termen slightly sinuate, slightly oblique; 12 connected by a bar with areole (1 ♂, 1 ♀), pale ochreous-grey with slight fuscous irroration, more in ♀, first line represented by a fuscous costal spot at one-third, and sometimes also by median and subdorsal dots, obsolete in ♀; a median, subcostal, fuscous, discal dot or small spot; postmedian line from a fuscous costal spot at two-thirds, angled inwards beneath costa, but upper limb of angle nearly obsolete, thence represented by a nearly straight line of fuscous dots to two-thirds dorsum, in ♀ tinged with ferruginous but nearly obsolete; subterminal fuscous dots slightly developed or obsolete; a terminal series of fine fuscous dots; cilia concolorous. Hindwings with termen rounded; as forewings, but without first line; postmedian line curved, slightly developed.

Whether this species is distinct from *T. epigaea* must remain uncertain until more material is secured. The neurational distinction of itself appears insufficient, and the only other I can find is the apparently slightly longer ciliations of the antennae of the ♂.

Queensland: Mt. Tambourine, in March and April.

43. TAXEOTIS EPIGAEA.

Turn., *Trans. Roy. Soc. S. Aust.*, 1904, 225.

♂. 26-32 mm. ♀. 29 mm. Head whitish-brown or whitish-grey; face dark fuscous or ferruginous-fuscous. Palpi in ♂ 1¼, in ♀ 1½; dark ferruginous-fuscous. Antennae grey, often whitish-brown towards base; in ♂ laminate, with a double row of tufts of long cilia (1½). Thorax and abdomen grey-brownish. Legs fuscous; posterior pair ochreous-whitish, sometimes irrorated with fuscous. Forewings triangular, costa very slightly arched, apex rather acutely pointed, termen slightly sinuate, moderately oblique; 12 free, but sometimes closely approximated to areole (12 ♂, 1 ♀); grey-brownish or reddish-brown, sparsely irrorated with fuscous, which sometimes forms transverse strigulae; first line represented by a fuscous or ferruginous-fuscous spot on costa at one-third, and a usually disconnected fine fuscous or ferruginous line from one-third dorsum, toothed outwards above dorsum and in middle of disc, sometimes reduced to two small dots, or even obsolete; a median, subcostal, fuscous, discal dot; postmedian arising from a second similar costal spot at two-thirds, angled acutely inwards beneath costa, but upper limb of angle usually undeveloped, thence sinuate to two-thirds dorsum, entire or reduced to a series of dots, fuscous or ferruginous, succeeded by a pale line, sometimes double; a subterminal series of dark fuscous dots variably developed, sometimes

pale-edged posteriorly, that above dorsum sometimes enlarged; a terminal series of blackish dots; cilia concolorous. Hindwings with termen rounded; as forewings, but without first line; post median line usually faint.

Variable; best distinguished by structural characters of palpi and antennae from all but the preceding.

North Queensland: Kuranda near Cairns, Herberton, Eungella. Queensland: Mt. Tambourine, National Park (2,000 feet to 3,000 feet), Toowoomba. From September to November.

44. Taxeotis compar, n. sp.

compar, similar.

♂. 26-28 mm. ♀. 30 mm. Head pale-grey; face ferruginous-fuscous. Palpi in ♂ 1½, in ♀ 2; ferruginous-fuscous. Antennae ochreous-grey-whitish becoming grey towards apices; in ♂ slightly laminate, shortly ciliated (½). Thorax and abdomen pale ochreous-grey with a few fuscous scales. Legs ochreous-grey, posterior pair ochreous-whitish, with more or less fuscous irroration. Forewings triangular, costa nearly straight, apex in ♂ rather acutely pointed, in ♀ acute and slightly produced, termen slightly sinuate, slightly oblique; 12 free (3 ♂, 2 ♀); pale ochreous-grey, in ♀ brownish, with a few fuscous scales; first line from a fuscous spot on one-third costa, outwardly curved to one-third dorsum, interrupted, or represented by two dots, ferruginous-fuscous, in ♀ faint or obsolete; a median, subcostal, fuscous, discal dot or spot; postmedian line from a second fuscous costal spot (both spots may be obsolete in ♀), angled inwards beneath costa, but upper limb of angle often not developed, sinuate to two-thirds dorsum, fuscous-ferruginous, sometimes reduced to a series of dots, succeeded by a pale line, which is usually edged posteriorly with fuscous, so that postmedian line appears double; sometimes a suffused streak from apex to postmedian line; a subterminal series of fuscous dots, pale-edged posteriorly, variably developed; a terminal series of blackish dots; cilia concolorous. Hindwings with termen rounded; as forewings, but without first line, and often without discal dot.

Allied and very similar to *T. epigaea*, yet certainly distinct by the short antennal ciliations of ♂.

Queensland: Toowoomba in November; five specimens received from Mr. W. B. Barnard.

Genus 3. Antasia.

Darantasia Wlk., *Cat. Brit. Mus.*, xxvi, 1743 (*praeocc.*).—*Antasia* Warr., *Novit. Zool.*, 1894, 366; Prout, *Gen. Insect.*, Oenochrom., p. 31.

Face smooth, with a small anterior tuft at lower edge. Tongue present. Palpi moderate, porrect, thickened with appressed hairs. Antennae of ♂ shortly bipectinate to near apex. Thorax and abdomen slender; the former slightly hairy beneath. Femora smooth. Tarsi not spinulose. Forewings with areole present, 11 anastomosing strongly to form a double areole, 12 connected by a bar with areole. Hindwings with 6 and 7 stalked, 12 approximated to cell to near its end.

Contains only the following species:—

45. Antasia flavicapitata.

Tephrina flavicapitata Gn., *Lep.*, x, 98.—*Tephrina capitata* Wlk., *Cat. Brit. Mus.*, xxiii, 965.—*Darantasia mundiferaria* Wlk., *ibid.*, xxvi, 1743.—*Darantasia*

flavicapitata Meyr., Proc. Linn. Soc. N.S.W., 1889, 1152.—*Antasia flavicapitata* Prout, *Gen. Insect.*, Oenochrom., Pl. i, f. 12.

New South Wales: Katoomba, Adaminaby. Victoria: Melbourne, Beaconsfield, Gisborne. Tasmania: Hobart, St. Helen's, Launceston, Strahan. South Australia: Mt. Lofty.

Genus 4. Tapinogyna.

Prout, *Gen. Insect.*, Oenochrom., p. 32.

Face smooth, without tuft. Tongue present. Palpi moderate, porrect, thickened with appressed hairs. Antennae of ♂ moderately bipectinate to near apex. Thorax and abdomen slender; the former not hairy beneath. Femora smooth. Tarsi not spinulose. Forewings with areole present, 11 anastomosing strongly to form a double areole, 12 connected by a bar with areole. Hindwings with 6 and 7 connate or approximated at origin, 12 approximated to cell to about middle, thence gradually diverging.

There is only one species which is certainly related to *Antasia*, but the differences in the neuration of the hindwings are sufficient to justify generic separation.

46. Tapinogyna perichroa.

Darantasia perichroa Low., *Trans. Roy. Soc. S. Aust.*, 1903, 187.

♂. 25-30 mm. ♀. 20-25 mm. Head grey, anterior edge sometimes whitish; face blackish. Palpi 2¼ to 2½; blackish, at base sharply white. Antennae in ♂ grey-whitish, in ♀ grey; pectinations in ♂ 2½. Thorax fuscous-grey, sometimes reddish-tinged. Abdomen grey. Legs fuscous, with some whitish irroration. Forewings rather broadly triangular, not so broad in ♀, costa gently arched, apex in ♂ round-pointed, in ♀ pointed, termen nearly straight, slightly oblique; pale grey, slightly reddish-tinged, with slight fuscous irroration; costa sometimes reddish-suffused; first line at one-fourth, represented by two or three fuscous dots; a median, subcostal, fuscous discal dot; postmedian at three-fourths, sinuate, represented by a series of fuscous dots; occasionally a short series of subterminal dots from costa; a terminal series of blackish dots, rarely obsolete; cilia pale grey, with a few darker scales. Hindwings with termen rounded; pale grey; a few fuscous scales on dorsum; usually a terminal series of fuscous dots; cilia pale grey.

Victoria: Stawell, Birchip, Sea Lake. South Australia: Pinnaroo. Western Australia: Perth.

Genus 5. Cathaemacta, nov.

καθαιμακτος, blood-stained.

Type, *C. thermistis* Low.

Face smooth. Tongue present. Palpi moderate (less than 2), porrect, shortly rough-scaled. Antennae of ♂ bipectinate almost to apex. Thorax and abdomen slender; the former not hairy beneath. Femora smooth. Tarsi not spinulose, or with minute spurs on posterior pair only. Forewings with areole present, 11 anastomosing strongly to form a double areole, 12 free. Hindwings with 6 and 7 separate, 12 approximated to cell to about middle, thence gradually diverging.

Differs from *Nearcha* in the separation of 6 and 7 of the hindwings and early divergence of subcostal vein from cell; from *Epidesmia* in the shorter palpi and

bipectinate antennae of ♂; from *Tapinogyna* in the absence of a bar between subcostal vein and areole.

47. Cathaemacta thermistis.

Epidesmia thermistis Low., *Trans. Roy. Soc. S. Aust.*, 1894, 81.—*Epidesmia cygnaea* Prout, *Gen. Insect.*, Oenochrom., p. 37, Pl. i, f. 17.

♂. 34-42 mm. Head grey, usually purple- or reddish-tinged; face dark red. Palpi 1½; dark red. Antennae ochreous-whitish; pectinations in ♂ 6. Thorax grey or purple-grey. Abdomen pale grey. Legs fuscous; middle and posterior tibiae and tarsi grey-whitish. Forewings triangular, costa straight, slightly arched towards base and apex, apex pointed, termen slightly rounded, moderately oblique; purple-grey sparsely irrorated with dark fuscous; costal edge red towards base; a fuscous dot on one-fourth dorsum, from which usually proceeds a straight red line towards, but not reaching, one-fourth costa; a median, subdorsal, dark fuscous, discal dot; a straight red line from two-thirds dorsum almost reaching costa near apex, more or less suffused with dark fuscous, and followed by a series of blackish dots; a terminal series of blackish dots; cilia pale grey or reddish-grey irrorated with dark fuscous. Hindwings with termen only slightly rounded; pale grey becoming whitish towards base; discal dot faint or absent; cilia pale grey with fuscous irroration.

Lower's type is a ♂ without antennae or palpi, Prout's a ♀ in Coll. Lyell.

South Australia: Adelaide. Western Australia: Perth, Waroona, Collie.

48. Cathaemacta loxomochla, n. sp.

λοξομοχλος, obliquely barred.

♂. 26 mm. Head, thorax and abdomen grey. (Palpi broken off.) Antennae grey; pectinations in ♂ short (1), each ending in a tuft of short cilia. Legs fuscous; posterior pair grey-whitish. Forewings rather elongate-triangular, costa gently arched, apex pointed, termen very slightly rounded, rather strongly oblique; grey sparsely irrorated with fuscous; a subcostal, blackish, discal dot slightly beyond middle; a black, gently doubly sinuate line from mid-dorsum towards, but not quite reaching, apex; a very obscure pale line parallel to this and about midway between it and termen; a terminal series of blackish dots; cilia grey. Hindwings with termen nearly straight, apex rounded; grey; a straight blackish line from three-fifths dorsum reaching three-fourths across disc; an obscure pale subterminal line; terminal dots and cilia as forewings.

I have no hesitation in referring this very distinct species to the genus *Cathaemacta*, although the antennal pectinations are much shorter than in the type, and the palpi are unfortunately missing.

Western Australia: Merredin; one specimen received from Mr. L. J. Newman.

Genus 6. Ecphyas, nov.

ἐκφυας, an off-shoot.

Face smooth. Tongue present. Palpi long, porrect. Antennae of ♂ unipectinate to near apex. Thorax and abdomen slender; the former slightly hairy beneath. Femora smooth. Tarsi spinulose. Forewings without areole, 10 from cell, closely approximated to, but not connected with, 9, 11 anastomosing strongly with 10. Hindwings with 6 and 7 approximated at origin, 12 approximated to cell to about middle, thence diverging.

A simple development of *Epidesmia*, from which it differs only in the disconnection of 10 from 9 causing disappearance of the areole.

49. Ecphyas holopsara, n. sp.

ὁλοψαρος, wholly grey.

♂, ♀. 42-45 mm. Head pale grey. Palpi 3½; pale grey. Antennae pale grey; pectinations in ♂ 3½. Thorax, abdomen, and legs pale grey. Forewings triangular, costa slightly arched, apex acute, termen sinuate, slightly oblique; pale ochreous-grey, sometimes with a few scattered fuscous scales; costal edge ochreous; first line obsolete, or represented by two faint dots; a median, subcostal, fuscous, discal dot; postmedian line nearly straight, from five-sixths costa to two-thirds dorsum, fuscous, sometimes edged with ochreous anteriorly, posteriorly suffused; a darker grey terminal band follows this, sometimes containing a crenulate fuscous subterminal line; cilia whitish-ochreous. Hindwings with termen nearly straight, tornus and apex rounded; grey; an antemedian fuscous discal dot; a median fuscous transverse line; cilia grey.

Western Australia: Mount Dale in January, Albany in February and March; three specimens received from Mr. W. B. Barnard, who has the type.

Genus 7. Systatica.

Turn., *Trans. Roy. Soc. S. Aust.*, 1904, 229.

Face smooth, not projecting. Tongue present. Palpi moderately long, ascending, closely appressed to face, reaching vertex, shortly rough-haired; terminal joint concealed. Antennae in both sexes unipectinate. Thorax and abdomen slender; the former not hairy beneath. Femora smooth. Tarsi minutely spinulose. Forewings with 7, 8, 9 stalked, 10 and 11 long-stalked from cell, separating on same level as 7, but 10 not connected with 9, 12 free. Hindwings with 6 from upper angle of cell, 7 from slightly above angle, 12 closely approximated to cell to beyond middle, thence diverging.

A development of *Epidesmia*, 10 and 11 being completely fused at origin as in *Satraparchis*, and 10 failing to anastomose with 9 as in *Ecphyas*, the areole being lost by separation. It is not intermediate between *Epidesmia* and *Oenochroma* as I at one time supposed. There is only one species known.

50. Systatica xanthastis.

Monoctenia ? *xanthastis* Low., *Trans. Roy. Soc. S. Aust.*, 1894, 85.—*Systatica xanthastis* Turn., *ibid.*, 1904, 229.

♂. 54-58 mm. ♀. 70 mm. Head and thorax pale brown, face dark fuscous-brown. Palpi dark fuscous-brown; basal joint red. Antennae fuscous; pectinations in both sexes 2½, apical one-fourth in ♂, apical two-fifths in ♀ simple. Abdomen pale ochreous-brown. Legs fuscous; coxae orange-brown. Forewings triangular, costa strongly arched at base, thence straight nearly to apex, apex acute, slightly produced, termen sinuate beneath apex, rather strongly bowed above middle; pale ochreous-brown, along costa and in terminal area suffused with brown; a nearly straight dark-brown line from one-third costa to beyond one-fourth dorsum; a linear, transverse, median, subcostal, brown discal mark; a dark brown line from costa at five-sixths slightly incurved to dorsum before three-fourths; a very strongly and acutely dentate, slender, pale, subterminal line; cilia dark brown, bases paler. Hindwings with termen slightly rounded; orange-

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ochreous with slight brownish suffusion towards tornus and dorsum; a nearly straight, postmedian, brown, transverse line; cilia brown, bases ochreous. Underside of forewings orange, costal and terminal areas, but not apex, fuscous-brown; of hindwings orange densely strigulated with fuscous-brown.

Queensland: Gympie, Nambour, Mt. Tambourine. New South Wales: Lismore, Allyn River, Mt. Wilson.

Genus 8. Satraparchis.

Meyr., Proc. Linn. Soc. N.S.W., 1889, 1158; Prout, *Gen. Insect.*, Oenochrom., 37.

Face smooth. Tongue present. Palpi long, porrect, loosely rough-haired. Antennae in ♂ unipectinate. Thorax and abdomen slender; the former not hairy beneath. Femora smooth. Tarsi not spinulose. Forewings with areole present, simple, 11 being fused to areole from base, 12 free. Hindwings with 6 and 7 stalked, 12 closely approximated to cell from near base to about three-fourths, thence diverging.

Only one species is known, which has retained the wing-pattern of an *Epidesmia*, with important differences in neuration. The areole is small and the bases of veins 10 and 11 are completely fused, so that what was once a double areole has become single.

51. Satraparchis bijugata.

Panagra bijugata Wlk., *Cat. Brit. Mus.*, xxvi, 1663.—*Melanippe teliferata* Wlk., *ibid.*, 1712.—*Satraparchis bijugata* Meyr., Proc. Linn. Soc. N.S.W., 1889, 1158.

Queensland: Rockhampton, Duaringa, Brisbane. New South Wales: Grafton, Sydney.

Genus 9. Epidesmia.

Westw., Duncan's Exot. Moths, 1840, 220; Meyr., Proc. Linn. Soc. N.S.W., 1889, 1159; Prout, *Gen. Insect.*, Oenochrom., 36.

Type, *E. tricolor* Westw.

Face smooth, rarely with loose projecting hairs. Tongue present. Palpi long or very long, porrect, rough-haired above and beneath. Antennae in ♂ unipectinate, towards apex simple, pectinations moderate or long. Thorax and abdomen slender; the former slightly or not hairy beneath. Femora smooth. Tarsi not spinulose, or with minute spurs on posterior tarsi only. Forewings with areole present, 11 anastomosing strongly to form a double areole, 12 free. Hindwings with 6 and 7 connate or closely approximated at origin, 12 approximated to cell as far as middle or two-thirds, thence diverging.

Key to Species.

1. Palpi very long, 3 to 6 2
   Palpi moderately long, less than 3 9
2. Forewings with a broadly elbowed, white, transverse fascia ..... *tricolor*. 52
   Forewings without white fascia 3
3. Hindwings fuscous with white transverse line ..... *oxyderces*. 53
   Hindwings not so 4
4. Hindwings orange ..... *chilonaria*. 54
   Hindwings not orange 5
5. Palpi fuscous with sharply defined white basal area 6
   Palpi grey, sometimes white at base 7

6. Hindwings with termen sinuate ..... *hypenaria*. 55
Hindwings with termen not sinuate ..... *tryxaria*. 56
7. Palpi white at base ..... *perfabricata*. 57
Palpi not white at base 8
8. Forewings with straight dotted postmedian line ..... *reservata*. 58
Forewings with postmedian line not straight, not dotted ..... *brachygrammella*. 59
9. Wings purple or reddish ..... *phoenicina*. 60
Wings not purple or reddish 10
10. Forewings fuscous with white lines from costa to tornus 11
Forewings grey with two blackish streaks from dorsum ..... *pachygramma*. 63
11. Hindwings white ..... *replicataria*. 61
Hindwings grey ..... *transcissata*. 62

52. EPIDESMIA TRICOLOR.

Westw., Duncan's Exot. Moths, p. 220, Pl. 28, f. 1; Meyr., PROC. LINN. SOC. N.S.W., 1889, 1159.

Queensland: Mt. Tambourine. New South Wales: Tuncurry, Sydney.

53. EPIDESMIA OXYDERCES.

Meyr., PROC. LINN. SOC. N.S.W., 1889, 1165.

Queensland: Mt. Tambourine, National Park (2,500 feet). New South Wales: Gosford, Sydney.

54. EPIDESMIA CHILONARIA.

Hemagalma chilonaria H.-Sch., *Ausser. Schmet.*, i, Pl. 62, f. 350—*Panagra aurinaria* Gn., *Lep.*, x, 127, Pl. 7, f. 7.—*Epidesmia chilonaria* Meyr., PROC. LINN. SOC. N.S.W., 1889, 1162.

Queensland: Nambour, Mt. Tambourine, National Park (2,500 feet), Toowoomba, Bunya Mts. New South Wales: Lismore, Ben Lomond, Dorrigo, Newcastle, Sydney. Victoria: Fernshaw, Beaconsfield, Gisborne.

55. EPIDESMIA HYPENARIA.

Panagra hypenaria Gn., *Lep.*, x, 128.—*Hemagalma inspersa* Feld., *Reise Novara*, Pl. 129, f. 19.—*Epidesmia hypenaria* Meyr., PROC. LINN. SOC. N.S.W., 1889, 1163; Prout, *Gen. Insect.*, Oenochrom., Pl. 1, f. 8.

New South Wales: Glen Innes, Ebor, Newcastle, Sydney, Katoomba, Mt. Wilson. Victoria: Melbourne, Beaconsfield, Gisborne, Dunkeld. Tasmania: Hobart, Mt. Wellington (2,500 feet), Russell Falls, Lake Fenton, St. Helen's, Launceston, Deloraine, Cradle Mt. (3,000 feet).

56. EPIDESMIA TRYXARIA.

Panagra tryxaria Gn., *Lep.*, x, 128.—*Epidesmia tryxaria* Meyr., PROC. LINN. SOC. N.S.W., 1889, 1164.—*Epidesmia phaedropa* Low., *Trans. Roy. Soc. S. Aust.*, 1893, 287.

North Queensland: Cairns, Atherton, Herberton, Mackay. Queensland: Yeppoon, Gympie, Nambour, Caloundra, Brisbane, Stradbroke Is., Mt. Tambourine, National Park (2,500 to 3,000 feet), Blackbutt, Toowoomba, Stanthorpe. New South Wales: Lismore, Port Macquarie, Gosford, Sydney, Bulli, Jervis Bay. Victoria: Beaconsfield.

57. EPIDESMIA PERFABRICATA.

Panagra perfabricata Wlk., *Cat. Brit. Mus.*, xxiii, 996.—*Epidesmia perfabricata* Meyr., PROC. LINN. SOC. N.S.W., 1889, 1165.

Queensland: Duaringa, Stradbroke Is., Toowoomba, Warwick. New South Wales: Glen Innes, Bathurst, Mt. Kosciusko (3,000 feet). Victoria: Beaconsfield, Gisborne.

58. Epidesmia reservata.

Panagra reservata Wlk., *Cat. Brit. Mus.*, xxiii, 996.—*Epidesmia reservata* Meyr., Proc. Linn. Soc. N.S.W., 1889, 1166.

North Australia: Darwin, Melville Is. North Queensland: Cape York, Claudie River, Cairns, Herberton, Mackay. Queensland: Rockhampton, Duaringa, Eidsvold, Nambour, Brisbane, Stradbroke Is., Mt. Tambourine.

Also from New Guinea.

59. Epidesmia brachygrammella.

Low., *Trans. Roy. Soc. S. Aust.*, 1893, 287.

♂, ♀. 44 mm. Head pale grey; face grey. Palpi 6; grey. Antennae pale grey; pectinations in ♂ 6. Thorax, abdomen, and legs pale grey. Forewings triangular, costa arched towards base, thence straight, apex acute, very slightly produced, termen gently rounded, moderately oblique; pale ochreous-grey; first line from one-fourth costa, pale fuscous, scarcely traceable, at first outwardly oblique, then angled inwards, thickened and blackish below middle with a posterior acute tooth, fading again at its termination at one-third dorsum; a median, subcostal, dark fuscous, discal dot; postmedian line from five-sixths costa, pale fuscous, indistinct, inwardly oblique, at one-third from costa thickened and blackish, doubly sinuate with two slight posterior teeth in disc, and an acute anterior tooth above dorsum, bent inwards and fading towards its termination at two-thirds dorsum; a subterminal series of fuscous dots; some indistinct terminal fuscous dots; cilia pale ochreous-grey. Hindwings with termen straight, apex and tornus rounded; pale ochreous-grey; a fuscous discal dot before middle; indistinct suffused postmedian and subterminal lines; cilia pale ochreous-grey.

Redescribed from Lower's type, which is in the South Australian Museum, and very distinct from any other species. The second example is a ♀ in Coll. Lyell.

Victoria: Croydon, near Melbourne, National Park (Wilson's Promontory).

60. Epidesmia phoenicina, n. sp.

φοινικινος, purplish.

♂. 40 mm. Head pale grey with a whitish line between antennae. Palpi 2½; pale grey. Antennae whitish-grey; pectinations in ♂ 6. Thorax purple-grey. Abdomen purple-grey; beneath mostly whitish. Legs purple-grey mixed with whitish, tarsi dark fuscous annulated with ochreous-whitish. Forewings triangular, costa straight to near apex, apex acute, termen sinuate, slightly oblique; purple-grey; a whitish costal line almost to apex; first line at one-fourth, fuscous, dentate, very fine and indistinct; a median, subcostal, discal dot, whitish, edged with fuscous; postmedian line straight, from three-fourths costa to two-thirds dorsum, slightly darker, lower half edged anteriorly with whitish; a subterminal series of minute fuscous dots, edged anteriorly with whitish, and connected with termen by fine whitish lines on veins; a terminal series of fuscous dots; cilia purple, apices whitish. Hindwings with termen rounded; as forewings, but without first line; a straight, distinct, transverse, median line. Underside whitish,

irrorated with purple-grey; discal white dots edged with fuscous; wavy postmedian and subterminal lines; a ferruginous blotch between these, below middle.

♀. 41 mm. Palpi 3; reddish-brown. Antennae very shortly unipectinate (two-thirds). Colour reddish-brown; postmedian lines yellowish; subterminal and terminal dots obsolete. Underside whitish-ochreous irrorated with reddish-brown; broad reddish-brown terminal bands containing a wavy subterminal line. The short pectinations of the ♀ antennae are a peculiar character.

North Queensland: Meringa (♂ type in Coll. Goldfinch) in November, and Kuranda (F. P. Dodd, ♀ type in Coll. Barnard), both near Cairns.

61. Epidesmia replicataria.

Phrataria replicataria Wlk., *Cat. Brit. Mus.*, xxxv, 1700.—*Epidesmia replicataria* Meyr., Proc. Linn. Soc. N.S.W., 1889, 1161.

Queensland: Mt. Tambourine, National Park (2,500 feet). New South Wales: Ben Lomond, Ebor, Katoomba, Mt. Kosciusko (5,000 feet). Victoria: Beaconsfield, Gisborne.

62. Epidesmia transcissata.

Phrataria transcissata Wlk., *Cat. Brit. Mus.*, xxvi, 1742.—*Epidesmia transcissata* Meyr., Proc. Linn. Soc. N.S.W., 1889, 1161.

New South Wales: Sydney. Victoria: Gisborne.

63. Epidesmia pachygramma.

Darantasia pachygramma Low., *Trans. Roy. Soc. S. Aust.*, 1893, 154.

♀. 18 mm. Head whitish; face fuscous. Palpi 2; fuscous. Antennae whitish. Thorax and abdomen whitish, with some fuscous irroration. Forewings rather narrowly triangular, costa nearly straight, apex acute, termen nearly straight, strongly oblique; whitish with sparse fuscous irroration appearing grey; a broad blackish streak from dorsum near base, nearly parallel to costa, ending in a point at two-fifths; a second similar streak from dorsum before tornus, nearly parallel to termen, slightly inwardly curved, ending in a fine point beneath apex; a terminal series of fuscous dots; cilia whitish. Hindwings with termen slightly rounded; pale grey.

Redescribed from Lower's type. This little species is not near any other. Its appearance suggests a *Dichromodes*, but it has the neuration of *Epidesmia*. Its generic location cannot be definitely fixed in the absence of the ♂.

Western Australia: Eucla.

Genus 10. Arcina.

Arcina Wlk., *Cat. Brit. Mus.*, xxvi, 1743; Prout, *Gen. Insect.*, Oenochrom., 28.

Face with strong, obtuse, triangular, anterior convexity. Tongue present. Palpi long, subascending and closely appressed to face from base, thence porrect, thickened with loosely appressed hairs. Antennae of ♂ bipectinate to near apex, pectinations moderately long, those on inner side rather shorter. Thorax and abdomen slender; the former hairy beneath. Femora smooth. Tarsi with minute spines on posterior tibiae only. Forewings with areole present (according to Prout sometimes disconnected), 11 closely approximated to areole, and occasionally shortly anastomosing with it near its apex, 12 free. Hindwings with 6 and 7

closely approximated at origin, 7 arising from just before angle, 12 approximated to cell to three-fourths, thence diverging.

There is only one species, a large and handsome insect, which I have already sufficiently described. The sexes are similar.

64. Arcina fulgorigera.

Wlk., *Cat. Brit. Mus.*, xxvi, 1744.—*Prorocrania argyritis* Turn., *Trans. Roy. Soc. S. Aust.*, 1904, 226.

Western Australia: Mundaring, Waroona, Kelmscott, Albany.

NOTES ON AUSTRALIAN DIPTERA. XXII.

By J. R. Malloch.
(*Communicated by Dr. I. M. Mackerras.*)

(Two Text-figures.)

[Read 27th November, 1929.]

In this paper I present a few notes on the family Ortalidae which I have had lying beside me for some time, and because of the fact that I have now become engaged in a study of the family Tachinidae and also have to undertake some work on another order of insects, I have decided to publish them now rather than wait until I can put into the press a more comprehensive treatise on the family.

Genus Celetor Loew.

This genus because of its possession of two pairs of orbital bristles and its robust build will run down to Caption 3 in Hendel's key to the tribes of Platystominae (*Abh. Zool.-Bot. Ges. Wien.* 8, heft 1, 1914, 3). He relegates it to his Section E, which contains forms with the abdomen broadly ovate, broadest near the base, rather than to Section D in which the abdomen is spindle-shaped, broadest in the middle and narrowed at base and apex. The distinction between these two Sections is by no means sharply drawn, and it is frequently the case that it is necessary to run doubtful forms through not only both of their keys to genera, but also through Section C in order to discover their generic location. The genus now under consideration has the lower calypter small, about as large as the upper one, the arista bare, third antennal segment more than twice as long as wide, with a pointed upper apical angle, the face concave, without a central carina, the prosternum haired, metanotum bare; mesopleural bristle present, dorsocentral and acrostichal bristles one pair, scutellum haired, first posterior cell of wing slightly and gradually narrowed to apex, anal cell not lobed and the inclination of the vein at its apex outward below, and the femora normal.

Hendel segregates the genus with several others on the possession of a distinct sternopleural, but in the specimens before me that bristle is not clearly differentiated. The genus does not bear a close relationship to *Scholastes* Loew, next to which it is placed in Hendel's arrangement, nor is it closely related to *Lamprogaster* Macquart which immediately precedes it in the same paper, and I am inclined to think that it is out of place in this tribe, though I am not prepared definitely to remove it therefrom.

There are two species of the genus, both of them occurring in Australia, which Hendel separates as below.

A. Thorax and scutellum glossy black; base of wing with net-like black-brown markings; sides of face shining reddish-brown ..... *dentipes* Macquart

AA. Thorax and scutellum bright steel-blue; base of wing without net-like markings, with broad complete black-brown fascia; sides of face snow-white ..... *caerulea* Macquart

CELETOR DENTIPES Macquart.

I have not seen this species. Hendel records it from Sydney, N.S.W., and New Zealand. If the last mentioned record is based upon Schiner's "*Novara*" material, and it appears to be so, it is very probably erroneous. I have received a large collection of Acalyptratae from Mr. A. Tonnoir from New Zealand and there is no species in any manner resembling this one amongst them. In fact the family is very poorly represented in that country judging from my material.

CELETOR CAERULEA Macquart.

Four specimens from Sydney, N.S.W. (Froggatt). United States National Museum.

Hendel gives the same records as for the preceding species and the same doubt as to the authenticity of the New Zealand record must be expressed. Many of the species recorded by Schiner as from New Zealand do not occur there and are really from Australia.

Genus DASYORTALIS Hendel.

This genus is readily distinguished from any other in the subfamily by the dense hairs on the eyes, the presence of two pairs of orbital bristles, the plumose arista, and the presence of bristles on the upper side of the fifth wing-vein on the entire extent of the anal cell. The antennal foveae are shallow, the mouth margin slightly produced, mesopleural bristle present, sternopleural absent, lower calypter very short, femora normal, posterior inclination of the vein closing anal cell towards base of wing, first posterior cell not narrowed at apex, hind coxae bare at apices above bases of femora, abdomen with four basal visible tergites of female subequal, ovipositor broad.

No species of the genus has been rceorded from Australia up to the present, but in all probability some of them will yet be found in the northern section, as all four now known are from New Guinea.

DASYORTALIS COMPLENS Walker.

I have seen this species from the Solomon Islands, July-August, 1909 (W. W. Froggatt), and Kaiser Wilhelmsland (R. Schlechter). The first specimen is in the United States National Museum, the other in the Deutsches Entomologisches Museum, Berlin-Dahlem.

Genus DUOMYIA Walker.

In a previous paper in this series (These PROCEEDINGS, 53, 350), I have briefly referred to this genus and its affinities, at the same time recording the occurrence of the genotype, *obscura* Walker, in two Australian localities. More recently I received some additional material which belongs to the genus as accepted by Hendel, and in attempting to identify them by the key in Hendel's paper, already referred to above, met with but indifferent success. I have therefore been compelled to make a careful analysis of the forms involved, some of the results of which I present below.

In my previous paper I separated the genus from *Euprosopia* Macquart by its lacking setulae on the upper surface of the basal section of the stem vein of the wing, and having microscopic hairs on the apices of the hind coxae above the bases of the femora. But some species placed in *Duomyia* by Hendel lack the

hind coxal hairs and I must either modify my definition or realign the species. It is unfortunately not possible with the material in hand for me to give a complete synoptic key to the Australian genera of the subfamily, which is the only reliable method that will permit of definite identifications by others, but I have tried to present in my papers such characters as appear to me to be dependable for generic recognition. Later on I hope to have the material to present a complete generic key for the Australian genera.

In *Duomyia* in Hendel's sense, it seems possible to make use of the presence of erect hairs on the suprasquamal ridge for the separation of the genus from its closest allies. If we resort to this expedient, we find that it is possible to divide the Australian species into two groups, one with hairs on the disc of the scutellum and the hind coxae bare at apices above bases of femora, the other without hair on the disc of the scutellum, and with microscopic hairs on the apices of hind coxae above bases of their femora.

In the first group I place *tomentosa* Hendel, and possibly *sericea* Hendel also belongs here, while the second group will contain *obscura* and probably all the other Australian species, though there are at least two rather well defined groups in this aggregation also. I propose a new subgenus for *tomentosa* Hendel, basing it upon the characters cited in the preceding paragraph.

Subgenus DUOMYZA, nov.

Subgenotype, the following species.

DUOMYIA (DUOMYZA) TOMENTOSA (Hendel).

A rather pale species owing to the presence of quite dense grey dust covering the metallic greenish thorax and abdomen, augmented to some extent by the numerous pale yellow hairs on these parts. The scutellum is normally testaceous yellow, but sometimes the disc is partly dark. Hendel had but one female before him when he described the species, and the small dark spot on the anterior side of each tibia beyond the middle was either lacking or overlooked by him; it is present in all specimens I have examined. The fourth visible abdominal tergite of the female is usually testaceous at the apex. Wings hyaline, veins yellow.

The antennae are more widely separated than in the other species of the genus, the facial carina is widened from above to lower extremity, with fine vertical striae which converge above, and the other edge sharply carinate; arista bare; scutellum with four black marginal bristles.

Length, 7–12 mm.

Localities.—Kuranda and Herberton (Dodd), Townsville (G. F. Hill), and Bribie Is., January, 1914, no collector's name.

The first two from the Lichtwardt collection in the Deutsches Entomologisches Museum, Berlin-Dahlem, the last two from the C. F. Baker collection in the U.S. National Museum, Washington, the locality label on the last specimen in indifferent writing and hard to decipher.

I suspect that this species may be the same as *scutellaris* Macquart, the only difference between it and Macquart's description lying in the brownish-black frons of the latter.

Subgenus DUOMYIA Macquart.

Hendel in his key to the species of the genus segregates two groups: "Stirne grob runzelig, uneben." and "Stirne flach, eben, hochstens fein punkiert." The distinction is difficult for a novice to comprehend, as some of the species that

fall in the second segregate have the frons so coarsely punctured, at least anteriorly, that it may be really considered as rugose or wrinkled. However, the members of the first segregate known to me have no distinct frontal punctures except on the sides anteriorly, and all of them have more or less pronounced elevations or humps centrally, and to a lesser extent on sides, which elevations are lacking in the forms with centrally impunctate frons of the other segregate. In fact the prominent hump or convexity just in front of the anterior ocellus in the group with uneven frons is lacking in all the species of the second group.

The species of both the above groups now available to me may be distinguished as in the synoptic key below.

Key to the Species.

1. Fore femur with some short stout black posteroventral spines or bristles apically* 2
   Fore femur without short stout posteroventral bristles, sometimes with a more or less evident longitudinal ridge or elevation beyond middle on that surface .. 3
2. Fore femur with the posteroventral bristles very strong, spine-like, extending from well basad of the middle to the apex, the ventral edge in profile regular (Fig. 1*a*); scutellum entirely glossy, without a trace of dusting .. *spinifemorata,* n. sp.
   Fore femur with the posteroventral bristles not exceptionally strong, confined to the apical third beyond a quite pronounced elevation on same surface (Fig. 1*b*); scutellum glossy, the surface except margin with quite distinct whitish dust. ..... *irregularis,* n. sp.
3. Frons anteriorly deeply pitted or punctured on entire width, flat or slightly depressed above in front of the anterior ocellus 4
   Frons without evident punctures or pits on central portion anteriorly, always with some more or less noticeable humps or elevations, one of these between ocelli and middle of frons quite pronounced 5
4. Both cross-veins and the apex of wing distinctly clouded with dark brown; facial carina not much widened below, its width at mouth margin not half as great as length of the third antennal segment ..... *decora* Macquart
   Cross-veins and the apex of wing without dark clouds; facial carina much widened below, its width at mouth margin subequal to length of the third antennal segment ..... *punctifrons,* n. sp.
5. Wings not at all darkened at apices, only the subcostal cell dark; facial carina flat, with pronounced vertical furrows; antennae and palpi black .... *obscura* Walker
   Wings distinctly darkened at apices and in costal cell; facial carina not distinctly furrowed 6
6. Cloud in costal cell separated from the apical one by a clear space; facial carina flat below; palpi black; antennae not nearly twice as long as face at centre ..... *maculipennis* Hendel
   Cloud in costal cell connected with the one at apex along the costa; facial carina rounded below; palpi testaceous yellow; antennae about twice as long as face at centre ..... *nigricosta,* n. sp.

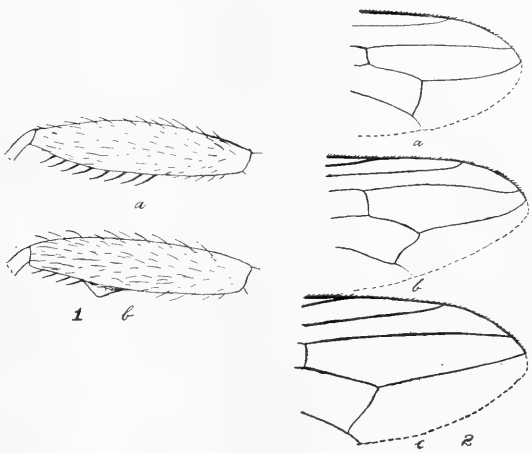
Duomyia (Duomyia) spinifemorata, n. sp.

Male.—Head testaceous yellow; occiput black, glossy across upper fourth, silvery-white below, vertex, ocellar spot and upper orbits shining black, sides of frons and parafacials narrowly yellowish-white-dusted, lunule shining black; cheeks usually brownish, lower portions of the antennal foveae darkened; antennae and palpi brownish-yellow. Thorax metallic blue-green, white-dusted along the lateral margins of the mesonotum in front of the suture, and narrowly along the latter, but not on its entire extent; mesopleura whitish-dusted above and behind; scutellum without dusting. Abdomen metallic violet-blue, hairs on the sides pale, on the disc black. Legs black, bases of tibiae more or less noticeably yellowish,

* Possibly only a male character as I possess only that sex of both species.

basal two or three segments of mid and hind tarsi whitish-yellow, their apices darker. Wings hyaline, costal cell brown, a faint brown cloud at apex of costa, and the inner cross-vein very faintly darkened. Calyptrae white. Knobs of halteres lemon-yellow.

Frons about one and a half times as wide as one eye, flat and smooth, with traces of a few shallow punctures on sides anteriorly, ocellar, orbital and post-vertical bristles undeveloped, the four verticals of moderate length; antennae about two-thirds as long as face, third segment wider than parafacial; arista haired on



Text-fig. 1.—Fore femora of *Duomyia* species. *a*, *D. spinifemorata*; *b*, *D. irregularis*.

Text-fig. 2.—Apical venation of wings of species of *Duomyia*. *a*. *D. spinifemorata*; *b*, *D. tomentosa*; *c*, *D. maculipennis*.

basal third, the longest hairs fully half as long as width of third antennal segment; facial carina sharp on edges, foveae not extending to level of mouth, the carina at lower level not as wide as the length of third antennal segment, its surface flat and smooth. Thorax with numerous piliferous punctures, the prescutellar acrostichals and dorsocentrals well developed; scutellum with six marginal bristles, the apical pair longest. Fourth visible tergite of abdomen very distinctly longer than second and third combined, without apical bristles. Fore and hind femora thicker than mid pair, only the fore pair armed ventrally. Inner cross-vein at about two-fifths from apex of discal cell; fourth vein curved forward at apex.

Length, 6–6·5 mm.

Type and five paratypes, Palmerston, N. Aust., December, 1908 (coll. Lichtwardt). In the Deutsches Entomologisches Museum, Berlin-Dahlem; one paratype deposited in the Australian Museum.

Duomyia (Duomyia) irregularis, n. sp.

This species is represented by a single male which has lost the head, so that it is not possible to give a full description of it.

In colour it differs from the preceding species in the whitish-dusted scutellum, the glossy black abdomen, and the wing with only the subcostal cell brown.

Structurally it differs in the form of the fore femora and their armature (fig. 1*b*).

Length, 6 mm.

Type, Palmerston, N. Aust., December, 1908 (coll. Lichtwardt). In Deutsches Entomologisches Museum, Berlin-Dahlem.

Duomyia (Duomyia) decora Macquart.

A rather small species, with much the same appearance as the two preceding species, but readily distinguished from them by the coarsely punctate frons, and clouded cross-veins of the wings. The antennae are as long as the face, and the facial carina is microscopically transversely striate. The legs are more largely rufous yellow than in the preceding species, only the fore femora being black, while the mid and hind femora are darkened at bases, and the tibiae and tarsi at apices. The fore femur has a slight ridge or carina on the posteroventral edge beyond the middle and many moderately long hair-like posterior bristles. Inner cross-vein close to middle of discal cell; fourth vein curved up at apex.

Length, 7 mm.

Locality, Botany Bay, N.S.W. (H. Petersen). Sent to me by C. F. Baker. Recorded by Hendel from Australia and Tasmania, without more definite locality.

Duomyia (Duomyia) punctifrons, n. sp.

A larger species than *decora*, with the wings unmarked except for a yellow tinge in the costal cell, and the legs differently coloured. The frons is fuscous, with a greenish cast anteriorly, more brownish behind, the upper portion of occiput is shining black, yellow in centre, the lower portion yellowish testaceous, with whitish dust; face testaceous yellow, antennae and palpi rufous yellow, third segment of former largely brown. Thorax metallic blue-green, with faint traces of two linear submedian dark vittae, lateral margins of mesonotum and upper portion of mesopleura grey-dusted. Abdomen concolorous with thorax. Fore legs black, mid and hind pairs honey-yellow, coxae and apices of femora and tibiae more or less distinctly blackened, apical two segments of these tarsi fuscous. Wings hyaline, subcostal cell yellow or pale brown. Calyptrae white. Halteres yellow, knobs brown.

Frons much as in *decora*, the two orbitals present, ocellars lacking; arista pubescent at base; antennae about four-fifths as long as face, third segment as wide as parafacial; facial carina microscopically transversely striate, without elevated edges. Thorax as in *spinifemorata*. Legs as in *decora*. Inner cross-vein at a little beyond the middle of discal cell; fourth vein curved forward at apex.

Length, 8·5 mm.

Type, Katoomba, Blue Mts., N.S.W., 3,400 feet, 1912 (Dodd), Deutsches Entomologisches Museum, Berlin-Dahlem.

Duomyia (Duomyia) obscura Walker.

I have nothing to add to my previous records of this species. It would appear worth noting that while *tomentosa* and the *decora* group have the apical portion of the fourth vein curved forward close to its apex, in the *obscura* group, containing this and the next two species, the fourth vein ends almost straight (figs. 2*a*–2*c*). Sometimes there are one or two weak hairs on the sides of the scutellum in *obscura*.

In Hendel's key, *obscura* is compared with *thalassina* Walker, both running to the same caption, and it is distinguished from it by the presence of a black spot between the base of each antenna and eye, the broader parafacials, and the entirely black face.

I have not seen *thalassina*.

DUOMYIA (DUOMYIA) MACULIPENNIS Hendel.

This is, next to *obscura*, the largest species of the genus I have seen, the specimen before me measuring 12 mm. in length. The frons is shining black, with white-dusted lateral margins, and an almost linear longitudinal elevation in front of the anterior ocellus, the facial carina is quite broad above, the sides curve outward to above middle and from there to the lower level it is nearly equally broad, the lateral edges are not sharp, and the centre is microscopically shagreened; there is a slight transverse depression across the face at lower extremity of the carina and the epistome projects slightly. Antennae as long as face, third segment as wide as parafacial; arista bare; palpi black. Legs black, tibiae and tarsi reddish-yellow, apical four segments of fore tarsi fuscous, apices of mid and hind tarsi less evidently darkened. Wings quite distinctly yellow, subcostal cell and apex of costa from before tip of second vein brown. Calyptrae white. Knobs of halteres fuscous. All femora thickened, fore and hind pairs most noticeably so.

Herberton, Q., December, 1910, 3,700 feet (Dodd). Deutsches Entomologisches Museum, Berlin-Dahlem.

Described from Sydney, N.S.W., and North Australia.

DUOMYIA (DUOMYIA) NIGRICOSTA, n. sp.

Male and female.—Frons shining black, lateral margins with a white-dusted line which is continued down over parafacials, face glossy orange-yellow, blackened in antennal foveae and there distinctly silvery-white-dusted; antennae brown, second segment orange; labrum and palpi orange-yellow. Thorax and abdomen glossy metallic blue-green, the former whitish-dusted along the notopleural suture. Legs black, tibiae and tarsi yellowish-brown, fore pair darker, apical four segments, sometimes all, of fore tarsi, and the tip of fifth segment of other pairs, fuscous. Wings dark brown along the costa from apex of auxiliary vein to apex of fourth. Calyptrae white. Halteres brown.

Frons about one and a half times as long as wide, sharp at vertex, with two central elevations, the additional one at anterior margin, and some lateral wrinkles, the orbitals lacking; face short, the carina sharp only above, rounded and poorly margined on lower half of face; antennae nearly twice as long as face in centre; arista pubescent. Thorax as in the preceding species, the prescutellar acrostichals and dorsocentrals present, and the scutellum bare. Femora less swollen than in *maculipennis*.

Length, 8–9 mm.

Type, male, and allotype, Cairns, Q. (coll. Lichtwardt). Deutsches Entomologisches Museum, Berlin-Dahlem.

Of the species not identified in this paper, *laeta* Walker is a homonym of *Lamprogaster laeta* Guérin, and has therefore no standing at present; *sericea* Hendel, *thalassina* Walker, and *scutellaris* Macquart have been referred to in the text, *annulipes* Hendel and *azurea* Hendel belong to the section with punctate frons,

and *mithrax* Hendel belongs to the same section as *obscura*, running down to *maculipennis*, but distinguished from it by the short-haired arista and clouded outer cross-vein of the wing.

Genus EUPROSOPIA Macquart.

Amongst new material available to me I find one undescribed species, and specimens of some others which provide new locality records for the species they represent.

EUPROSOPIA PUNCTIFACIES Malloch.

Three specimens, Kuranda, Q., February, 1910, and one specimen, Cairns, Q., no collector's name. Deutsches Entomologisches Museum, Berlin-Dahlem.

EUPROSOPIA MILIARIA Hendel.

One specimen, Kuranda, Q., January, 1910, no collector's name. Deutsches Entomologisches Museum, Berlin-Dahlem.

This is the first recorded occurrence of this species in Australia.

EUPROSOPIA MACROTEGULARIA Malloch.

One female, Cairns, Q., 1907; one male, Kuranda, Q., February, 1910, no collector's name. Deutsches Entomologisches Museum, Berlin-Dahlem.

EUPROSOPIA SEPARATA Hendel.

Two specimens, Cairns, Q., 1907; two specimens, Kuranda, Q., February, 1910, no collector's name. Deutsches Entomologisches Museum, Berlin-Dahlem.

EUPROSOPIA CONJUNCTA Hendel.

Three specimens, Herberton, Q., January, 1911, 3,700 feet (Dodd).

EUPROSOPIA BIARMATA, n. sp.

Female.—Extremely like *conjuncta* Hendel, the wing markings almost the same, the only differences in my specimens being that in the costal cell there are but three dark marks besides the one at humeral cross-vein instead of four or five, and the cell behind the stem of veins 2 and 3 is almost uniformly fuscous instead of having four or more transverse dark streaks. The apex of the scutellum is dark brown and, though shining, is not glossy as in *conjuncta*, and the legs are brownish-yellow, with the apices of tibiae darker, and the tarsi black, with basal segment except the tip white.

Structurally similar to *conjuncta*, differing in having the tegular process stouter, slightly clubbed at apex, and below it on the pleura a sharp-pointed lanceolate process which is directed forward and about as long as the tegular one. In *conjuncta* this second process is represented by a very short thorn. The first visible abdominal tergite lacks the yellow scale-like apical hairs of *conjuncta*, the hairs being all slender. The scutellum is not so noticeably sulcate at apex, and the lateral elevations are therefore less prominent than in *conjuncta*.

Length, 8·5 mm.

Type, Herberton, Q., 3,700 feet, February, 1911 (Dodd). Deutsches Entomologisches Museum, Berlin-Dahlem.

In my previously published key this species will be difficult to place because it is about intermediate between the group with sulcate and that with non-sulcate scutellum. If it is placed in the former the characters cited above will dis-

tinguish it from *separata*. If on the other hand it is placed in the second segregate it will run down to Caption 4, where it is distinguished from *miliaria* by the fasciate wings, and from the species listed in the following captions by the four scutellar bristles and the pleural process, as well as by other characters.

EUPROSOPIA TIGRINA Osten-Sacken.

This species looks like a small *tegularia* Malloch, but the wings are differently marked, having a narrow dark fascia from the stigma over the entire width of wing, a broader one over the outer cross-vein which narrows posteriorly, and between that one and apex of wing a complete fascia which connects with the apical spot on the costa. The pleura has a central yellow-dusted vitta, the mesonotum has three such vittae, as has also the abdomen. The legs are black, with the bases of mid and hind tibiae broadly yellowish, and the basal segment of tarsi reddish-yellow, least noticeably so on the fore pair, the hind pair more whitish.

Arista of male with an apical palette, tegula of same sex slightly produced forward, scutellum narrowly rounded at apex and with four bristles.

Length, 8 mm.

Kaiserwilhelmsland, Minjam River (R. Schlechter). In the Lichtwardt collection, Deutsches Entomologisches Museum, Berlin-Dahlem.

The only record since its original description. Not known from Australia.

Genus PTEROGENIA Bigot.

This genus is distributed over the Orient and southward to Australia, two species, *latericia* Hendel and *nubecula* Hendel, occurring in Queensland. It is entirely probable that some of the species which occur in New Guinea may yet be found to occur in the northern portion of Australia.

I have seen no Australian examples of the genus, but expect later to return to it in one of my papers.

Genus NAUPODA Osten-Sacken.

This genus is rather similar to the preceding one, differing essentially in wing venation and some other details.

The distribution of the genus differs from that of *Pterogenia* in that there are several African species. Only one Australian species has been recorded, but it is not unlikely that some of the other species may extend their range into Australia.

NAUPODA REGINA Hendel.

This species has been very well described and the wing figured by Hendel in the paper already referred to, so that it is not necessary at this time to deal further with it.

Cairns, 1907, and Kuranda, Q., February, 1910 (coll. Lichtwardt). Deutsches Entomologisches Museum, Berlin-Dahlem.

Genus LAMPROGASTER Macquart.

Since the publication of my paper dealing with the species of this genus known to me, I have received a number of specimens, mostly from the Lichtwardt collection, through the courtesy of Dr. Walther Horn, of the Deutsches Entomologisches Museum. This material contains a male of *pumicata* van der Wulp,

described from a similar example from the same locality, New Caledonia, and not seen by Hendel when he wrote his paper on the subfamily, as well as a series of what I take to be *laeta* Guérin, also unknown to Hendel. I still lack representatives of *apicalis* Walker, *maculipennis* Macquart, *vella* Walker, *jucunda* Walker, *unimacula* Hendel, *poecila* Hendel, and *hilaris* Walker, of the recorded Australian species. Of those, besides the species he described, Hendel had seen only *jucunda*, so that the generic reference may not be accurate in all cases. I present below a key to the species now before me.

Key to the Species.

1. Scutellum without fine hairs in addition to the marginal bristles 9
   Scutellum with either the entire surface or a portion on each side haired 2
2. Wings entirely without dark markings, at most with the inner cross-vein very slightly darkened 3
   Wings with quite evident dark markings on costa 5
3. Mesonotum with a well developed pair of prescutellar acrostichal bristles; general colour of dorsum rufous, with a conspicuous metallic blue tinge, the mesonotal hairs and bristles black; scutellum slightly sulcate at apex centrally .... *elongata* van der Wulp
   Mesonotum lacking distinguishable prescutellar acrostichal bristles 4
4. General colour of dorsum of thorax and abdomen deep metallic violet-blue; face with a dark streak on each side from antennal fovea to mouth; mesonotum with the bristles and hairs black ..... *xanthoptera* Hendel
   General colour of dorsum of thorax and abdomen testaceous yellow, with a more or less evident metallic blue or violet tinge, the hairs on both yellow; face yellow ..... *zelotypa* Hendel
5. Entire costal margin of wings broadly dark brown except in the costal cell, outer cross-vein with a conspicuous brown cloud; scutellum haired on entire disc ..... *stenoparia* Hendel
   Wing with more or less conspicuous black or brown costal markings, but not with a complete costal brown mark 6
6. Scutellum haired on entire disc and with a quite conspicuous apical central sulcus; wing markings very indistinct except the one at apex of costa and a cloud on inner cross-vein; fourth visible abdominal tergite of male hardly longer than third; sides of mesonotum and entire pleura fulvous yellow, disc of former broadly blue-green, without grey-dusted vittae; scutellum fulvous yellow, with more or less distinct bluish tinge, not as dark as disc of mesonotum .... *indistincta* Malloch
   Scutellum haired on the sides of disc only, more or less broadly bare in centre; the costal markings very conspicuous, the dark mark over apices of basal cells not extending entirely to the costa 7
7. Second and third visible abdominal tergites of male extremely short, linear, their combined lengths not more than one-tenth as great as that of fourth tergite; legs rufous yellow, apices of femora, bases and apices of tibiae, and the entire tarsi, fuscous; outer cross-vein of wing quite broadly clouded with brown ..... *viola*, n. sp.
   Second and third abdominal tergites of male not extremely short, their combined lengths more than half as long as that of fourth tergite; legs yellow, at most with the apices of tarsi slightly darkened; outer cross-vein at most very narrowly clouded 8
8. Fulvous yellow species, with more or less conspicuous metallic blue tinge, scutellum bluish-black and much darker than the mesonotum, the hairs on its sides and those on mesonotum pale; mesonotum without any trace of grey-dusted vittae ..... *laeta* Guérin
   Metallic blackish-green species, the scutellum more distinctly shining than mesonotum, but not darker than it, the hairs on its sides sparse and, like those on disc of mesonotum, fuscous or black; mesonotum with three quite distinct grey-dusted vittae ..... *pumicata* van der Wulp

9. Thorax fulvous yellow, with a broad metallic blue-green stripe on mesonotum on which are one or three grey-dusted vittae, the dark mark on costa at level of inner cross-vein deep black; outer cross-vein not clouded 10
Thorax and abdomen metallic blackish-green or blue-green 11
10. Legs black, bases of tarsi brownish, mid and hind femora and tibiae in female sometimes more or less yellowish centrally; no distinct dark mark at apices of basal cells; the dark preapical spot on second vein extremely small .... *flavipennis* Macquart
Legs honey-yellow, bases of fore femora, apices of tibiae and tarsi, darkened, the tibiae least evidently so; a conspicuous blackish mark at apices of basal cells of wing which extends to costa at humeral cross-vein; preapical spot on second vein moderately large ..... *bicolor* Macquart
11. Thorax and abdomen metallic blackish-green, not highly polished, the mesonotum with three quite evident grey-dusted vittae; legs fulvous yellow, apical three segments of each tarsus brown or fuscous ..... *pumicata* van der Wulp*
Thorax and abdomen metallic blue-green, highly polished, the mesonotum without a trace of grey-dusted vittae; legs honey-yellow, fore femora sometimes slightly dark at apices, fore tibiae and tarsi, and the apical two segments of mid and hind tarsi, brown or fuscous ..... *lepida* Walker

LAMPROGASTER ELONGATA van der Wulp.

Very similar to *zelotypa* Hendel, but distinguishable by the characters cited in the foregoing key.

Cairns, Q. (coll. Lichtwardt).

Recorded from New Guinea, Key Island and Molucca, but not previously known from Australia.

LAMPROGASTER XANTHOPTERA Hendel.

Three examples from New Pommern, taken by the same collector as, and evidently from the same lot as, the type. Not known from Australia.

LAMPROGASTER ZELOTYPA Hendel.

Two specimens, Cairns, Q., 1907 (coll. Lichtwardt).

LAMPROGASTER STENOPARIA Hendel.

Five specimens, Cairns, Q., 1907 (coll. Lichtwardt).

LAMPROGASTER VIOLA, n. sp.

Male.—Frons black, yellowish-grey-dusted along each side in front; parafacials with similar dust; face brownish testaceous, with dense grey dust in foveae and along carina adjacent to them; cheeks and occiput fuscous, the latter pale-grey-dusted; antennae brownish testaceous, third segment dark brown except at base; aristae and palpi black. Thorax and abdomen brilliant metallic violet-blue, sides of mesonotum and pleura sometimes deep rufous brown, with overlying blue lustre, underside of scutellum and the metanotum coloured as pleura; thoracic and abdominal hairs black. Legs black, coxae castaneous, femora largely reddish-yellow basally, sometimes to apical third, tarsi entirely black. Wings yellow along costal half and with the usual four dark marks, the one at apices of basal cells faint, most evident in the apices of the cells and hardly visible costally, apical spot pale brown, outer cross-vein with a quite evident brown cloud. Calyptrae brownish, with brown margins. Halteres yellow, knobs fuscous.

* Because of the sparse hairing on the sides of scutellum this species is placed in the sections "with" and "without" scutellar hairs.

Each orbit with one moderately well developed upper bristle; antennae more than half of the face length; arista pubescent on basal fifth; cheek about twice as high as width of third antennal segment. Prescutellar acrostichal and dorsocentral bristles well developed; the scutellum almost entirely haired, bare central area narrow, with six marginal bristles, and a broad shallow central apical depression. Abdomen rather pointed, fourth tergite about as long as hind femur, without apical bristles. Legs and wings normal.

Length, 13 mm.

Type and one paratype, Herberton, N.Q., 3,700 feet, January, 1911 (Dodd).

Type in Deutsches Entomologisches Museum, Berlin-Dahlem, paratype in Australian Museum.

LAMPROGASTER LAETA Guérin.

This species has much the appearance of *elongata*, but the scutellum is much more conspicuously blue than the mesonotum, and there are four dark marks on the costal portion of the wing, the one at apices of the basal cells not extending to the costa, and the stigmatal one tripartite, while the outer cross-vein is darker than the other veins, though not evidently clouded. Legs yellow, apical two or three segments of each tarsus slightly darkened.

Arista short-haired at base. Sides of the scutellum with some quite long pale hairs. Abdomen armed as in *pumicata*, but the bristles on the fourth visible tergite much shorter and weaker.

Length, 10–12 mm.

Herberton, N.Q., December, 1910, 3,700 feet (Dodd). Nine specimens. Two specimens will be sent to the Australian Museum.

First known record since the original description.

LAMPROGASTER PUMICATA van der Wulp.

This species has the frons black, the cheek with a large black-brown triangle, the legs yellow, with coxae and apical three segments of each tarsus brown, the dark mark over apices of the basal cells of wing not extending to the costa, the preapical one on second vein subquadrate and quite conspicuous, and the abdominal hairs mostly yellow.

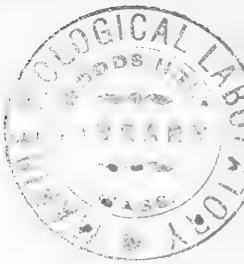
The antennae are fully one-half of the length of the face, the arista has very short hairs, and the face is smooth on central carina. The prescutellar acrostichal and dorsocentral bristles are strong, and there are only a few black hairs on each side of the scutellum at base. First visible abdominal tergite with two short bristles in centre of apical margin, second with four such bristles, third and fourth each with a complete apical series, long on sides of third and on entire extent of fourth.

Length, 11 mm.

New Caledonia (Osten-Sacken). The collection label bears the erroneous locality "Neuseeland" above the name. Not known from Australia.

LAMPROGASTER LEPIDA Walker.

Herberton and Cairns, N.Q., 1907 (coll. Lichtwardt). Twenty-one specimens.



A LIST OF THE AUSTRALIAN BOMBYLIIDAE OF THE SUBFAMILIES EXOPROSOPINAE, ANTHRACINAE, AND BOMBYLIINAE IN THE GERMAN ENTOMOLOGICAL MUSEUM, BERLIN.

By Frederick H. S. Roberts, M.Sc.

[Read 30th October, 1929.]

Through the courtesy of the Director of the German Entomological Museum I have received for identification, Australian Bombyliidae of the subfamilies Exoprosopinae, Anthracinae, and Bombyliinae. The specimens are mainly from Northern Australia, collected by F. P. Dodd and Lichtwardt, whilst a few were captured by A. P. Dodd at Katoomba, New South Wales. Locality labels are given, but the only date recorded is the year of capture.

Subfamily Exoprosopinae.

Genus Hyperalonia Rondani.

H. doryca Boisduval.—Four specimens from Cairns.
H. inquinita Roberts.—One specimen from Herberton.
H. sinuatifascia Macquart.—Six specimens from Darwin.
H. bombyliformis Macleay.—Eight specimens from Darwin.
H. satyrus Fabr.—Eleven specimens from Cairns, Sellheim and Darwin.
H. septentrionis Roberts.—Four specimens from Darwin.
H. cingulata v. d. Wulp.—One specimen from Darwin.

Of the nine species recorded as belonging to this genus seven are represented in the collection. The northern limits of *cingulata* and *inquinita* have been extended from Alice Springs (Central Australia) to Darwin and from the Bunya Mts. (Queensland) to Herberton.

Genus Exoprosopa Macquart.

E. adelaidica Macquart.—One specimen from Adelaide.

The specimen here is the large form recorded as form (1) in my Revision of the Australian Bombyliidae, Part 1 (Proc. Linn. Soc. N.S.W., liii, Pt. 2, 1928, 107).

Genus Villa Lioy.

V. obscura Macquart.—One specimen from Herberton.
V. aprica Roberts.—Three specimens from Katoomba.
V. commista Macquart.—One specimen from Cairns.
V. fuscicostata Macquart.—Three specimens from Cairns and Katoomba.

The northern limits of *obscura*, *commista*, and *fuscicostata*, were previously the Eungella Range, Pt. Denison and Palm Is. (Queensland); *obscura* is now

known from Herberton, whilst *commista* and *fuscicostata* are now known to extend to Cairns.

Genus PSEUDOPENTHES Roberts.

P. fenestrata Roberts.—One specimen from Cairns.

The former northern limit of this species was Brisbane.

Subfamily ANTHRACINAE.

Genus ANTHRAX Scopoli.

A. angularis Thomson.—Three specimens from Darwin.

A. concisa Macquart.—One specimen from Katoomba.

A. angularis was formerly known to extend only as far north as Pt. Denison.

Subfamily BOMBYLIINAE.

Genus BOMBYLIUS Linn.

B. australianus Bigot.—Four specimens from Katoomba.

B. succandidus Roberts.—One specimen from Cairns.

The small pale-haired and clear-winged *succandidus* is now known as far north as Cairns. Its previous northern record was Chinchilla.

Genus SYSTOECHUS Loew.

S. australis Guérin.—One specimen from Katoomba.

S. albiceps Macquart ?—Six specimens from Kuranda and Herberton.

I am rather doubtful of this last identification. The species *albiceps* and *sericans* are so closely allied that a distinction cannot usually be made except with specimens in good condition. These six specimens are all more or less damaged, but the species seems more like *albiceps*.

Genus SISYROMYIA White.

This genus is represented by two rather mutilated specimens from Katoomba. The species could not be determined.

DESCRIPTIONS OF NEW SPECIES OF AUSTRALIAN COLEOPTERA. XX.

By Arthur M. Lea, F.E.S.

(Eight Text-figures.)

[Read 30th October, 1929.]

Family Mordellidae.

Mordellistena cairnsensis, n. sp.

Black, in some lights with a bright bluish gloss, parts of antennae and of front legs obscurely diluted with red. With fine blackish and greyish pubescence.

Rather thin. Aculeus rather long and thin. Antennae passing base of hind legs. Hind tibiae with four cuts, the second long, the others short, apical spurs very unequal; first and second tarsal joints obscurely notched. Length, 2 mm.

Queensland: Cairns district (F. P. Dodd). Unique.

A minute species, about the size of *M. concolor*, from Western Australia, but with griseous clothing in parts; *M. atronitens* is larger, not greyish, and in certain lights more brilliantly iridescent. At first glance it appears to be a *Mordella*, but the cuts on the hind legs are sufficiently distinct on close examination, although partly concealed by pubescence. From most directions the head appears to be brilliant blue, with a darker central spot, the spot altering in position with the point of view, from the front to the back, but always along the middle. On the head, prothorax, legs and most of the under surface the pubescence is greyish-white, on the elytra it is mostly dark, but whitish on the suture and shoulders, with a faint V, usually traceable (even to the naked eye), but altering with the point of view.

Mordellistena subpellucida, n. sp.

Flavous, with a faint bluish gloss, tips of elytra slightly infuscated, cuts on hind legs and tips of some of the joints black. Clothed with fine, pale pubescence.

Rather thin. Aculeus long and thin, rather suddenly dilated near base. Hind tibiae with three black cuts in addition to the black tip, the first short, second longer, third much longer; spurs very unequal; first and second joints of hind tarsi each with two conspicuous black cuts. Length, 3 mm.

Queensland: Kuranda (F. P. Dodd).

An unusually pale species, about one-third of the elytra appears to be infuscated; this is due mostly to the dark wings showing through, but on lifting an elytron it is seen to be really slightly infuscated posteriorly. It is paler than M. *fusca*, and is without the dark suture and shoulders of *M. longipes*. The pubescence nowhere forms patterns, but is fairly distinct; on the elytra a faint V, altering with the point of view, may usually be traced.

Mordellistena nitidicoma, n. sp.

Bright castaneous, with a faint bluish iridescence; metasternum, hind coxae, and most of hind femora more or less deeply infuscated. Rather densely clothed with pale, golden-brown, shining pubescence.

Rather narrow. Aculeus with apical half thin and then dilated to base, scarcely longer than two basal joints of hind tarsi. Hind tibiae with three distinct cuts, the first short, the others long and subequal, spurs very unequal; first joint of hind tarsi with three black cuts, second and third each with two. Length, 4·5-5·0 mm.

Queensland: National Park (H. Hacker), Cairns (F. P. Dodd). Type in Queensland Museum; cotype in South Australian Museum.

A fairly large species, somewhat larger than the average size of *M. austrina*, with brighter pubescence, which on the elytra forms a V (altering with the point of view), quite distinct to the naked eye, and with some of the under parts dark (on one specimen, however, the under parts, except for the cuts on the hind legs, are entirely pale). The aculeus is not as sharp as on *M. coelioxys*.

MORDELLISTENA TORRESENSIS, n. sp. Text-fig. 1.

Flavous and black. Rather densely pubescent, the pubescence whitish on the flavous parts, mostly blackish on the dark parts.

Rather narrow. Antennae extending to base of hind legs. Aculeus very thin, but not very long. Hind tibiae with three sharp black cuts, the first short, second somewhat longer, third much longer; spurs very unequal; first and second joints of hind tarsi each with two black cuts. Length, 2·25 mm.

Queensland: Murray Island (A. M. Lea). Unique.

A prettily variegated species. The head is entirely pale, the pronotum is mostly pale, but with a conspicuous black spot on each side of the middle, on the elytra the black occupies more than half of the surface, and consists of a large spot about the scutellum, a postmedian fascia suddenly dilated at the middle (with the front part passing the tip of the scutellar spot), a subapical fascia and the tips; but the paler portion of the derm itself, between the tips and the postmedian fascia, is not conspicuously paler than the adjacent parts, although appearing distinctly so owing to its white pubescence; the metasternum, hind coxae, and parts of the legs are black.

MORDELLISTENA ALTERNIZONA, n. sp. Text-fig. 2.

Black and flavous. With black and white pubescence, the black almost confined to the black parts of the upper surface.

Rather narrow. Aculeus long and thin. Hind tibiae with one short and three longer black cuts; apical spurs very unequal; first joint of hind tarsi with four black cuts; second joint with two. Length, 2·25 mm.

Queensland: Murray Island (A. M. Lea). Unique.

Structurally close to the preceding species, but the colours of the upper surface are in sharply contrasted zones; the head is entirely flavous, the prothorax is black, with the basal third flavous, the elytra have the basal third black, then a broad pale zone (slightly encroaching on the black zone along the suture), then a longer black zone, followed by the pale tips. Most of the under surface is black or infuscated, the antennae and front and middle legs are pale, the hind legs mostly infuscated. It is about the size of *M. castigata*, but the base of the elytra is black.

MORDELLISTENA PURPUREOTINCTA, n. sp.

Reddish-castaneous with a slight bluish gloss; elytra with a median fascia (narrower about the suture than towards the sides) and the apical fourth

infuscated. Moderately clothed with stramineous or somewhat golden pubescence, becoming darker on the dark parts of elytra.

Moderately narrow. Aculeus moderately long, narrow, but rapidly dilated near base. Hind tibiae with one short and two long black cuts; spurs very unequal; first joint of hind tarsi with three black cuts, the first very short, second joint with two cuts. Length, 3 mm.

Queensland: Cairns district (F. P. Dodd). Type in South Australian Museum; National Park (H. Hacker), in Queensland Museum.

With faint markings suggestive of those of *Mordella caloptera*, but with the hind legs of a *Mordellistena*. *M. pulcherrima* is a decidedly narrower species, with apical markings well defined. The bluish gloss of the upper surface is more pronounced on the darker parts than elsewhere, on the darker parts also the pubescence in some lights appears purplish.

Mordellistena megacera, n. sp.

Deep black, in places with a metallic blue gloss, parts of abdomen and of legs obscurely diluted with red. With black pubescence, becoming silvery on parts of under surface.

Narrow. Antennae with second and third joints small and subequal, third to tenth serrated, third widely triangular, fourth to tenth slightly increasing in length, but becoming less triangular, eleventh elongate-elliptic, thinner and slightly longer than tenth. Hind tibiae with five sharply defined cuts; apical spurs rather long, the longer about one-fourth more than the other; first joint of hind tarsi with three cuts, the second with two. Length, 5 mm.

Queensland: Kuranda (F. P. Dodd). Unique.

A deep black species, with conspicuous cuts on the hind tibiae and tarsi. The antennae are longer, with the fourth to tenth joints considerably larger than on any other species before me; and, on account of them, it may eventually be considered advisable to place it in a new genus. Although the pubescence on the elytra is uniformly dark, from some directions it appears to form six narrow vittae on each elytron.

Mordellistena megalops, n. sp.

Black, parts of antennae and of legs obscurely reddish. Moderately clothed with black and greyish pubescence, the latter clothing the sides and apex of prothorax and forming four spots on the disc: two in middle and two at base; on the elytra it narrowly clothes the base, suture, and tips, and forms three short obscure vittae at the base of each, and several feeble ones elsewhere.

Rather narrow. Eyes unusually large, being almost as wide as the space separating them. Aculeus acute, about as long as the elytra are wide at base. Hind tibiae with three acute cuts, the third longer than the others, spurs long and unequal, first joint of tarsi with three cuts, second with two. Length, 3·5 mm.

Queensland: Rockhampton. Unique.

A narrow black species with unusually large eyes. On the pronotum the four pale discal spots are fairly distinct, on each elytron the three basal vittae are fairly distinct from some directions, but the others are very feeble.

MORDELLISTENA CONCINNA Lea.

A second specimen, slightly larger (3 mm.) than the type, was also trapped in the Cairns district by a sticky seed of *Pisonia brunoniana*.

MORDELLA TRILOBIBASA, n. sp. Text-figs. 3, 4.

Bright castaneo-flavous, with black markings on elytra and under parts. With golden pubescence, becoming blackish on the black parts.

Moderately robust. Aculeus acute and moderately long. Spurs to hind tibiae unequal. Length, 4·5 mm.

Queensland: Brookfield, in March (H. Hacker). Type in Queensland Museum.

A beautiful species, intermediate between *M. caloptera* and *M. calodema*; from the former it differs in being slightly more robust and having median fascia of elytra conspicuously interrupted in middle; on the under surface there is a black mark or deep infuscation on each hind coxa, continuing the median fascia on the elytra (not on the metasternum as on several specimens of *caloptera*). The

Text-figs. 1-7.—Elytral markings of 1, *Mordellistena torresensis* Lea; 2, *M. alternizona* Lea; 3 and 4, *Mordella trilobibasa* Lea; 5, *M. mesoleuca* Lea; 6, *M. poeciloptera* Lea; 7, *M. tetrastictoptera* Lea.
Text-fig. 8.—Prothoracic markings of *M. leucosticta* Germ. var.

trilobed basal spot is almost exactly as on the type of *calodema*, but the median fascia and markings on the under surface are different. On the elytra the black parts consist of a large trilobed scutellar spot, a fairly wide median fascia, interrupted in the middle and the apical fourth; on the under surface there is a large round spot adjacent to the median fascia, and the tips of some of the joints are black.

A specimen from Sydney (in the collection of Mr. F. Erasmus Wilson) apparently belongs to this species, but differs from the type in being smaller (4 mm.), and in having the median fascia on the elytra reduced to two small, oblique, disconnected spots; the dark spot on each side of the under surface is almost exactly as on the type.

MORDELLA MESOLEUCA, n. sp. Text-fig. 5.

Black, front and middle femora flavous, front and middle tibiae and antennae darker but not black. With whitish pubescence, on the elytra confined to narrow markings.

Rather narrow. Aculeus sharp, about as long as the elytra are wide at the base. Spurs to hind tibiae unequal, the longer not half the length of the first tarsal joint. Length, 3 mm.

South Australia: Ooldea (A. M. Lea). Unique.

A small subparallel-sided species with distinctive markings on the elytra; these consist of a narrow sutural stripe to about the middle, where it is traversed by a narrow fascia and then terminates; near the apex there is another fascia and there is a short vitta on each shoulder; on the pronotum the clothing from most directions appears to be uniformly pale, but from others a faint dark median vitta and a small spot on each side become visible.

MORDELLA POECILOPTERA, n. sp. Text-fig. 6.

Black, basal half of antennae and front legs more or less obscurely flavous. Clothed with stramineous or golden-grey pubescence, elytra with black pubescence and numerous pale spots and vittae.

Rather robust. Aculeus moderately long and acutely pointed. Spurs to hind tibiae moderately long and unequal. Length, 6 mm.

New South Wales: Upper Williams River (A. M. Lea). Unique.

The elytral markings are unlike those of any other species before me, are more complicated than on *M. v-aurea*, and on a different plan; they may be considered as broken up remnants of four or five longitudinal stripes on each elytron.

MORDELLA TETRASTICTOPTERA, n. sp. Text-fig. 7.

Black, parts of antennae and of front legs obscurely diluted with red. Moderately clothed with greyish-white pubescence, on the elytra black, but each with two whitish spots, one at the basal third, the other postmedian.

Rather narrow. Aculeus moderately long, apical half thin, then rather strongly dilated to base. Spurs to hind tibiae very unequal, the shorter one not half the length of the other. Length, 3·5 mm.

North Australia: Groote Eylandt (N. B. Tindale). Unique.

On the type the pale clothing has a rather dull appearance, but it is probable that on fresh specimens it would be silvery. There is a rare variety of *M. humeralis* with somewhat similar spots on the elytra, but even on that variety the shoulders are reddish. The hind edge of the hind tibiae is finely serrated, but as there are no deep cuts its does not appear desirable to refer the species to *Mordellistena*.

MORDELLA LEUCOSTICTA Germ. Text-fig. 8.

A specimen from North Australia (Groote Eylandt) has elytral markings as on normal specimens of this species, and the markings on the base of the prothorax the same; but on the apex of the prothorax the markings are white, containing four disconnected black spots, there are also two longitudinal white vittae extending from the white part half-way to the base.

MORDELLA CALOPTERA Lea.

Mixed with several ordinary specimens of this species recently received from Mr. F. P. Dodd from Kuranda, were three specimens with the basal markings of the elytra completely absent, but otherwise as previously figured (Lea, *Trans. Roy. Soc. S. Aust.*, 1917, Pl. xv, fig. 115).

Family CURCULIONIDAE.

MYLLOCERUS APHTHOSUS Pasc.

A specimen from the Stewart River (Queensland) differs from some typical members of this species in having the scales of a faint whitish-blue colour, and the elytra with more numerous and mostly conjoined spots.

Myllocerus torridus Blackb.

Although not mentioned in the original description the prothorax of this species has two distinct transverse impressions, both interrupted in the middle; as a result it has the general appearance of *M. rugicollis*, but the prothorax is distinctly wider at the base than at the apex. Seven specimens from Groote Eylandt probably represent a variety of the species; they differ from a cotype in being smaller (5-6 mm.), and in having the upper surface more noticeably mottled, and the elytral setae much less conspicuous.

Myllocerus melvillensis Lea.

Two specimens from Groote Eylandt evidently belong to this species, with which they would be associated in the 1914 table of the genus; one of them agrees well with the type, but the other is considerably larger (7 mm.) and has the scales of the upper surface mostly sooty-brown; in general appearance they are close to *M. griseus*, but the prothorax of that species is without transverse impressions.

Myllocerus rugicollis Lea.

Two males from Groote Eylandt possibly represent a variety of this species (hitherto known only from Queensland); they differ from typical males in having the antennae decidedly longer and thinner, the femora more strongly dentate, and the elytra with numerous small brownish spots; the front coxae are not armed, but each of them has a feeble depressed tubercle, or small granule, at the position of the conical tubercle of *M. rugicollis* and its close allies.

Myllocerus laticollis Lea.

On the under surface of its rostrum this species has an acutely conical process directed backwards, somewhat as on *M. mirabilis*. On a long series of the species recently taken at Bathurst Head (Northern Queensland) the darker scales vary in extent, sometimes being represented by hardly more than a median spot (apparently always present) on each elytron, sometimes covering most of the surface, but leaving a pale median line on the pronotum.

Myllocerus pteroderes, n. sp.

Dull reddish-brown. Densely clothed with whitish-grey scales, on the upper surface feebly variegated with inconspicuous pale brown spots.

Head moderately wide, with dense, concealed punctures. Eyes lateral and prominent. Rostrum about as long as its basal width, with three narrow and well defined costae. Antennae rather long, scape flattened towards apex, with its under surface there grooved, first joint of funicle almost as long as second and third combined. Prothorax at apex about as wide as the median length, and about half the width of base, sides strongly obliquely dilated to the base, where each is flanged, the flange slightly overlapping the elytra, apex faintly incurved at middle, base with a wide median lobe, thence faintly sinuous to sides; with sparse, normally concealed punctures. Elytra punctate-striate, the punctures about one-third the width of the interstices, but appearing much smaller through the clothing. Femora unarmed. Length, 9 mm.

Central Australia: Hermannsburg (H. J. Hillier). Type (unique) in British Museum.

Allied to *M. laticollis*, but larger, base of prothorax just perceptibly wider than elytra, instead of very distinctly so, its apex slightly incurved to middle, and rostrum longer. From *M. latibasis* it differs in having the head slightly more convex, and narrower between the eyes, prothorax with apex narrower and less incurved to middle, and sides more obliquely dilated to base, the base itself is not deeply and evenly bisinuate, as on that species, and the elytra are not separately evenly rounded at the base, but each has a slight incurvature before the shoulder, as a result the base appears unequally trisinuate. *M. chaunoderus* is a much smaller species, with very different head. To the naked eye the upper surface of the type appears to be of a uniform shade of grey, slightly darker than the under surface, but under a lens numerous faint spots may be seen; the club has infuscated scales. At first glance the muzzle and legs appear to be the only parts that are setose, but on close examination a row of small, sparse, depressed setae may be seen on each elytral interstice; on the apical slope they are more distinct than elsewhere, but even there they are traceable with difficulty.

MYLLOCERUS HOPLOSTERNUS, n. sp.

♂. Black. Clothed with black and green scales, the latter sometimes with a coppery or bluish gloss.

Eyes large, but not very prominent. Rostrum wedge-shaped, shorter than eyes; scrobes feebly separated in front. Antennae long and thin, second joint of funicle slightly longer than first. Prothorax longer than wide, sides increasing in width to near apex, and then slightly dilated; with small punctures, normally concealed. Elytra almost parallel-sided to near apex, base trisinuate; with regular rows of large punctures, appearing much narrower through clothing. Prosternum with an acute projection in middle behind coxae. Femora edentate. Length (including rostrum), 4·5–5·0 mm.

♀. Differs in having prosternum unarmed.

Queensland: Stewart River in February (H. M. Hale and N. B. Tindale); abundant.

The eyes and rostrum are much as on *M. ceratorhinus*, but the sides of the prothorax are very different. *M. brachyrhynchus*, with somewhat similar eyes and rostrum, has the prothorax much narrower at the base. On *M. armipectus* the prosternum has a projection, but it is smaller and nearer the base. There are some long setae about the base of the elytra, but not enough to warrant the species being referred to B *d* of the 1914 table of the genus; in that table it could be associated with *M. speciosus*, but the rostrum and many other characters are different. Regarding the ground scales as green, the black ones form two complete vittae on the pronotum, and on the elytra numerous spots, many of which are combined into irregular fasciae; on the under surface the scales are pale green, becoming whitish along the middle. The clothing is easily abraded, especially from the pronotum, which on some old specimens appears almost entirely shining black.

MYLLOCERUS OBLIQUICOLLIS, n. sp.

Black, legs obscurely reddish. Densely clothed with greyish-white scales, slightly infuscated on parts of upper surface, uniformly white on under surface.

Eyes large but not very prominent. Rostrum very short, scarcely the length of eyes. Antennae long and thin, second joint of funicle slightly longer than first. Prothorax wider than long, sides evenly decreasing in width to apex, which

is scarcely more than half the width of base; punctures normally concealed. Elytra comparatively wide, parallel-sided to beyond the middle; striate-punctate, punctures large, but appearing much smaller through clothing. Femora unarmed. Length, 4–5 mm.

Queensland: Stewart River in February (H. M. Hale and N. B. Tindale).

The eyes and rostrum are much as those of the preceding species, but the prothorax and clothing are very different. In the 1914 table of the genus, it could be associated with the species of B *ww*, from all of which it is distinguished by the rostrum, which is much as on the preceding species and *M. ceratorhinus* and *M. brachyrhynchus*. The setae are confined to a single row on each interstice, and are inconspicuous even from the sides.

Myllocerus inermipes, n. sp.

Black, parts of antennae and legs obscurely reddish. Clothed with ashen, slightly variegated scales. With numerous short sloping setae, very distinct from the sides.

Eyes large, but not very prominent. Rostrum slightly longer than basal width, about twice the length of eyes, sides gently decreasing in width to apex, a fine carina on each side, between the eyes and apex. Antennae long and thin, first joint of funicle slightly longer than second. Prothorax twice as wide at base as the median length, sides gently bisinuate, apex feebly incurved to middle, and about three-fourths the width of base; punctures normally concealed. Elytra parallel-sided to near apex, each separately strongly rounded at base; with rows of large punctures, appearing small through clothing. Femora edentate. Length, 4·0–4·5 mm.

North Australia: Daly River (H. Wesselman).

The prothorax is faintly incurved at apex, but the incurvature is not sufficient to allow the species to be referred to B *h* of the 1914 table of the genus; in that table it could be associated with the species of B *uu*, but it differs from *M. castor* and *M. confinis* in the prothorax having oblique sides, punctures smaller, eyes larger but less prominent, and rostrum flatter, etc.

Myllocerus trisinuatus, n. sp.

Black, antennae and legs obscurely reddish. Densely clothed with ashen, or greyish-white scales, with a slight greenish tinge, the prothorax with an irregular median dark vitta, the elytra multimaculate or immaculate. With depressed setae; on the elytra mostly confined to a single row on each interstice.

Eyes moderately large and not very prominent. Rostrum not much longer than wide, sides gently incurved. Antennae moderately long and thin, first joint of funicle distinctly longer than second. Prothorax moderately transverse, sides gently rounded, apex straight and about two-thirds the width of base; with large, concealed punctures. Elytra feebly dilated to beyond the middle, base trisinuate; striate-punctate, the punctures large but appearing much smaller through clothing. Femora acutely dentate. Length, 5·0–5·5 mm.

North Australia: Bathurst Island in October (G. F. Hill).

Of the two specimens (still fast *in cop.*) before me, the male has numerous small infuscated spots on the elytra, and a fairly wide median vitta on the pronotum; the female has the median vitta quite as distinct, but its elytra are immaculate. The female has a distinct transverse impression on each side of the pronotum; they are symmetrical, but are possibly accidental. In the 1914 table

of the genus, the species could be associated with *M. fugitivus*, from which it differs in its black derm and ashen clothing, with a median vitta on pronotum. *M. foveifrons* has more uniform clothing, and stouter antennae and legs. In general appearance it is somewhat like *M. obscurus*, but is smaller and decidedly narrower. From the preceding species it differs in the rounded sides of its prothorax, trisinuate base of elytra, and dentate femora.

MYLLOCERUS TRIVITTICOLLIS, n. sp.

Blackish-brown, antennae (club excepted) and legs more or less reddish. Densely clothed with whitish scales, the pronotum with three complete brownish vittae, the elytra with numerous small brownish spots, except on the suture and sides. With numerous pale, depressed setae, but on the elytra a regular row of fairly long erect ones on each interstice; front tibiae with a fringe of hairs on lower surface.

Eyes elliptic and rather long, but not very prominent. Rostrum not very long, sides subcontinuous with those of head. Antennae moderately long; first joint of funicle distinctly longer than second, the others comparatively short. Prothorax almost as long as wide, strongly convex, sides strongly rounded, base not much wider than apex; punctures concealed but indicated by setae. Elytra separately rounded at base, conspicuously wider than prothorax, parallel-sided to beyond the middle; striate-punctate, punctures appearing narrow through clothing. Femora edentate. Length, 5 mm.

South Australia: Barton (A. M. Lea); unique.

A distinct species with subglobular pronotum; the base is not much wider than the apex, so it could be referred to B in the 1914 table of the genus, and there associated with *M. canalicornis*, which is without long elytral setae; regarding it as belonging to BB C, it could be associated with *M. suturalis* and *M. villosipennis*, from which it differs in the strongly rounded trivittate prothorax, besides many other features. In some lights some of the white scales on the under surface have a bluish or coppery gloss; many of the elytral spots are transversely confluent. The tibial fringe may be a masculine feature.

MYLLOCERUS PERARMATUS, n. sp.

♂. Dull reddish-brown, antennae (club excepted) and legs paler. Densely clothed with whitish-grey scales, with numerous brown spots on upper surface, under surface with uniformly white scales. With numerous setae, mostly pale on the under surface and legs, mostly dark on the upper surface; on the elytra suberect and forming a distinct row on each interstice, but irregular on the third.

Eyes large, elliptic and not very prominent. Rostrum short and wide, with three thin carinae. Antennae (for the genus) not very thin, first joint of funicle distinctly longer than second. Prothorax moderately transverse, sides rather strongly rounded, base and apex subequal; with numerous large, setiferous punctures. Elytra much wider than prothorax, base gently trisinuate, sides parallel to beyond the middle; striate-punctate, punctures fairly large, but appearing narrow through clothing. All coxae acutely dentate, femora stout, acutely dentate, tibiae multidenticulate. Length, 5·5–7·0 mm.

♀. Differs in having the antennae somewhat smaller, prothorax distinctly smaller, sides less strongly rounded, a shallow transverse impression near apex, and another near base, the latter usually with a short impression on each side of middle, abdomen more convex and legs thinner, with unarmed coxae.

Queensland: Magnetic Island (A. M. Lea).

The male coxae are armed much as on *M. armipes*, from which the species is at once distinguished by the suberect setae; these are conspicuous from all directions, but on that species even from the sides the upper surface appears nonsetose. In many respects it approaches *M. tibialis*, but the tibiae and coxae are very different. *M. coxalis*, with somewhat similar legs, is a much narrower species, with paler clothing. Seen directly from behind, the elytral setae appear to form an almost regular row on each interstice; they are, however, not long enough to entitle the species to be referred to C, in the 1914 table of the genus; the females could be associated with *M. melvillensis* and *M. rugicollis*, from which they are distinguished by the numerous suberect setae; the males with *M. varius* and *M. fuscomaculatus*, which have unarmed coxae, and differ in other respects. The spine on each of the hind coxae is smaller than the others, but quite as acute. The head has usually two distinct dark vittae, but on some specimens its clothing is uniformly pale; the pronotum usually has several feeble vittae, but occasionally has pale scales only, the setiferous punctures, however, give it a "flea-bitten" appearance; the elytral spots vary considerably in number and disposition, and are often irregularly confluent.

Genus Mandalotus.

Almost every collector in Australia who has searched for insects in places where species of this genus are likely to occur, has obtained specimens of it, hence the numerous species I have been able to name from time to time. The males of more than half the known species may be readily distinguished by structural features of the under surface and legs. Of the other species many are quite distinct when placed side by side with their allies. Owing to their method of living, however, many are so covered with mud, or have had their scales and setae dirtied or abraded, that their clothing is not of much assistance towards their identification. The derm also (as with many other densely clothed weevils) is liable to considerable variation in colour; normally with most mature specimens it is black or blackish, but many are more or less reddish, even those that have shed their deciduous mandibular appendages; on such specimens the clothing is usually in better preservation, but not much reliance may be placed on anything but sculpture.

Mandalotus funereus Lea.

A specimen in Mr. F. E. Wilson's collection from Mount Painter (Victoria) taken at an elevation of 4,000 feet in January, evidently belongs to this species, but has fewer black scales, and the strong arcuation of the base of the elytra is slightly interrupted on each side, to a certain extent approaching that of *M. ferrugineus*.

Mandalotus pentagonoderes, n. sp.

♂. Of a rather pale castaneous, scape dark brown. Densely clothed with brownish scales, in some lights with a golden or golden-red gloss; in addition with numerous curved setae, varying from stramineous to black, and becoming suberect between the eyes; front tibiae with a fairly long pale fringe on lower surface.

Head with a narrow interocular impression. Rostrum moderately long, with three ridges obscured by clothing. Antennae rather long and thin. Prothorax slightly transverse, sides dilated from base to near apex, and then suddenly narrowed to apex itself, which is somewhat uplifted in middle; with numerous

fairly distinct granules, a shallow depression in middle close to apex and with a feeble median line. Elytra moderately long, no wider than widest part of prothorax; with numerous obtuse tubercles, and with series of rather narrow punctures, in places deflected by granules. Abdomen with a large shallow depression. Prosternum with a truncated process projecting between middle coxae, these distinctly but not widely separated. Femora stout, tibiae rather long, the hind ones somewhat flattened, slightly twisted and with small setiferous granules. Length, 7 mm.

Victoria: Warburton, 4,000 feet, in tussocks, in December (F. E. Wilson); unique.

The front coxae are but slightly separated; between them there is a triangular process produced backwards, which meets a similar process produced forwards, but their junction is below the general level (the insect viewed on its back) as on several other species with the front coxae almost touching, but between the posterior third of the coxae there is another process which is produced obliquely upwards, with its apex truncated. Regarding the prosternum as tuberculate the species could be referred to B in the 1926 table of the genus (*Rec. S. Aust. Mus.*, iii, 152) and there associated with *M. prosternalis*; on that species (a much smaller one) the process is distinctly a tubercle, and entirely behind the coxae; on the present species the process is a truncated projection partly between the coxae. Regarding the species, however, as belonging to F in that table, it might be associated with *M. hypulus*, which is a smaller species, with fewer tubercles on the elytra. The hind angles of the prothorax are rounded off, otherwise its upper surface would be a perfect pentagon. There are ten tubercles on each elytron, mostly clothed with darker scales than on the adjacent parts, there are three on the third interstice, a basal one interrupting the even incurvature of the base, a small one at the basal fourth, and a fairly large one crowning the apical slope; there are also three on each of the fifth and seventh interstices, with one below the shoulder; the fourth has a feeble elongate swelling, which, although scarcely a tubercle, is sufficient to deflect the row of punctures on each side of it. The type is probably immature.

Mandalotus dolens, n. sp.

♂. Dark brown, some parts obscurely paler. Densely clothed with brownish scales, in parts brownish-grey; in addition with numerous suberect or sloping setae, mostly brownish, and on the elytra confined to a single row on each interstice; under surface of front tibiae with a rather long, pale, loose fringe.

Rostrum rather short, with a narrow median carina, and almost concealed sublateral ridges. Antennae moderately long. Prothorax moderately transverse, sides rather strongly rounded; with a feeble median line and with numerous small granules, partly traceable through clothing. Elytra nontuberculate, sides rounded and widest at about basal fifth, base evenly arched; with rows of rather large, deep punctures, appearing much smaller through clothing. Intercoxal process of mesosternum small, conically produced in front. Basal segment of abdomen gently depressed in middle. Front coxae distinctly, but not very widely separated, femora stout, hind tibiae with a small tooth at apical two-fifths on the inner surface. Length, 4·5–5·0 mm.

Queensland: Maryborough (E. W. Fischer).

In general appearance near *M. auchmeresthes*, with which it could be associated in the 1926 table of the genus, but the intercoxal process of the mesosternum

not truncated in front, and hind tibiae with a small inner tooth, nearer the apex than base; it is, however, invisible from most directions. A second male has the under surface and parts of the legs pale castaneous, probably from immaturity.

MANDALOTUS FIMBRIATUS, n. sp.

♂. Black, antennae and tarsi obscurely diluted with red. Densely clothed with sooty-brown scales, and with numerous suberect setae, on the elytra formed into a single row on each interstice; tibiae fringed on under surface.

Rostrum moderately long, with three ridges (including the median carina) indicated through clothing. Antennae rather long, first joint of funicle longer than second. Prothorax moderately transverse, sides strongly rounded, with a feeble median line; with numerous small rounded granules, slightly traceable through clothing. Elytra at base strongly trisinuate and as wide as the widest part of prothorax, nontuberculate, but with an obtuse swelling behind each shoulder; with rows of large, round, deep punctures, wider than the interstices, but appearing much smaller through clothing. Basal segment of abdomen with a curved carina about one-third from apex, and connecting the hind coxae, the enclosed space between it and base almost glabrous, and with numerous small punctures. Front coxae almost as widely separated as middle ones; front tibiae with a moderate swelling on basal third of under surface, then strongly arched to apex; middle tibiae strongly dilated from base to near the middle, thence to apex with an almost semicircular notch. Length, 5–7 mm.

♀. Differs in having rostrum smaller, with a slight interocular granule, antennae shorter, prothorax considerably smaller and more transverse, elytra wider in proportion, basal segment of abdomen convex and noncarinate, front tibiae smaller, their apical portion less curved, and middle tibiae only gently incurved on apical half of under surface.

Victoria: Bogong Plains in January (F. E. Wilson), Alps (H. W. Davey).

In the 1926 table of the genus this species could be associated with *M. interocularis*, but the male is very distinct from the male of that species (as also from *M. arciferus* and *M. carteri*, with which it is closely associated) by the middle tibiae; each of these has a deep notch on the apical half, immediately preceded by a large tooth-like process (really the sudden termination of an enlargement from the base); on the three species referred to, the swelling on the basal half of each of the middle tibiae is gradual, and not abruptly ended in a tooth-like process. The interocular granule of the female is not a conspicuous reddish one as on *interocularis*, but appears to be more a slight thickening of the base of the median carina of the rostrum, which is elsewhere concealed by the clothing. The clothing is but little variegated on each individual, but on some specimens is more of a rusty-brown than sooty-brown, it is rather sparse on the under surface; on one female it is of a muddy-grey, with small sooty spots on the elytra; the fringe on the front tibiae of the male is more conspicuous than on the others. Of the pair from the Alps the male has distinctly longer fringes on the tibiae, and the tooth-like projection on the middle pair is not quite as prominent.

MANDALOTUS TUBERIPENNIS, n. sp.

♂. Dark reddish-brown, some parts paler. Moderately clothed with greyish or brownish scales, on some parts, in certain lights, with a slight metallic gloss; in addition with numerous curved or suberect setae.

Rostrum moderately long, median carina traceable throughout. Scape thickened at apex. Prothorax moderately transverse, sides dilated from base to near apex, and then strongly narrowed to apex itself; surface uneven, depressed in middle near apex, and with numerous round, partially concealed granules. Elytra trisinuate at base, just behind shoulders as wide as widest part of prothorax, third, fifth, and seventh interstices with obtuse tubercles, of which the largest is on the third at the summit of the apical slope; with somewhat irregular rows of large, partially concealed punctures. Basal segment of abdomen with a shallow depression, slightly continued on to second segment. Front coxae large, almost touching, femora stout, tibiae rather long and thin. Length, 4–5 mm.

♀. Differs in having somewhat smaller rostrum, with shorter antennae, prothorax more transverse, elytra shorter and wider in proportion, with more conspicuous tubercles, basal segment of abdomen evenly convex and legs shorter.

Victoria: Warburton, in tussocks at an elevation of 4,000 feet (F. E. Wilson).

In the 1926 table of the genus, this species could be placed with the species of F *dd*, and of the species placed there is in size about half-way between *M. hypulus*, and *norfolcensis* and *nodipennis*; the two latter species are wider in proportion, and differ in many other details; *hypulus* is larger, with fewer tubercles, shorter legs and different clothing. Behind the intercoxal part of the prosternum there is a slight process, indicating an approach to the peculiar one of *M. pentagonoderes*, but it is so feeble that it would not be fair to regard the species as belonging to B in the table, especially as it is alike on the sexes. In other respects also it approaches that species, but is much smaller. On the five specimens taken no part is truly black; on some of them parts of the abdomen are almost castaneous. The apical part of the scape is as wide as the widest part of the club.

MANDALOTUS ACANTHOCNEMIS, n. sp.

♂. Black, scape and funicle reddish. Densely clothed with muddy-brown scales; with rather short sloping and mostly pale setae, on the elytra almost confined to the odd interstices.

Rostrum moderately long, convex along middle, median carina scarcely traceable. Antennae rather thin. Prothorax as long as wide, sides feebly dilated from base to near apex, and then strongly narrowed to apex itself; with a feeble median line, and numerous small, round granules, traceable through clothing. Elytra nontuberculate, base feebly trisinuate and as wide as widest part of prothorax; with regular rows of punctures appearing very small through clothing; alternate interstices feebly elevated. Metasternum and basal segment of abdomen with a large conjoint excavation. Front coxae widely separated (more than the middle pair), femora stout, front tibiae with an acute tooth on the lower inner edge at the basal third. Length, 2·5 mm.

South Australia: Mount Lofty Ranges (A. H. Elston); unique.

In the 1926 table of the genus could be associated with *M. avenaceus*, from which it differs in being smaller, the tooth on the front tibiae smaller, more acute, without a ridge in front of it, prothorax distinctly longer, with distinct granules, and base of elytra distinctly trisinuate.

MANDALOTUS VILLOSIPES, n. sp.

♂. Blackish-brown, some parts reddish. Upper surface moderately clothed with more or less brownish, obscurely variegated scales, in some lights with a slight metallic gloss; and interspersed with suberect or sloping setae, on the

elytra confined to a single row on each interstice, but feeble on the even ones. Under surface with fine setose clothing; legs fringed with long thin hairs.

Rostrum with median carina distinct throughout. Antennae moderately thin. Prothorax as long as wide, sides gently rounded, apex not much narrower than base; with a fine median line, and numerous small, subobsolete granules, traceable through clothing. Elytra nontuberculate, conjointly arcuate at base, which is as wide as widest part of prothorax; with regular rows of large, deep punctures, appearing much smaller through clothing, alternate interstices feebly elevated. Metasternum and basal segment of abdomen with a trough-like excavation, slightly continued on to second segment. Front coxae distinctly but not widely separated, their distance apart about half that of the middle pair; femora stout; tibiae slightly bisinuate on lower surface. Length, 4–5 mm.

♀. Differs in having the rostrum smaller, prothorax somewhat transverse, with more rounded sides, elytra wider in proportion, metasternum and abdomen not excavated, and legs somewhat shorter.

New South Wales: Barrington Tops (J. Hopson).

The depression on the under surface of the male is large and fairly deep, and might be considered as entitling the species to be associated with *M. foveatus* in the 1926 table of the genus, but it is less sudden than on that species, is more trough-like in character, with the bottom fairly wide instead of very narrow; on *foveatus* also it is not continued on to the second segment. The prothoracic granules are also very different, both before and after abrasion, they are subobsolete but vary on the individual, so might be associated with the species of V, or VV, from all of which the males are abundantly distinct by the excavation of the under surface. It is really nearest of all to the Tasmanian *M. angustipictus*, but the excavation is narrower, less clothed, the prothoracic granules are much more feeble, and the clothing is less variegated. On some specimens the tibiae are conspicuously reddish, on others they are no paler than the femora; the club is usually darker than the rest of the antennae; one small female has the antennae, elytral suture, and under parts of a dingy castaneo-flavous. The fringes on the legs are not confined to the tibiae, but are continued on to the femora; they appear, however, to be easily abraded, as also are the scales.

Mandalotus corrugicollis, n. sp.

♂. Blackish, parts of antennae and of tarsi obscurely diluted with red. Densely clothed with sooty scales, variegated with slaty-grey on parts of upper surface, becoming whitish-grey on under parts; in addition, with numerous curved or suberect setae, mostly dark on the upper parts, mostly pale on the under parts; tibiae fringed.

Rostrum moderately long, median carina narrow and distinct throughout. Antennae rather thin. Prothorax almost as long as wide, sides rather strongly rounded, base not much wider than apex; disc conspicuously transversely sculptured. Elytra at base, which is gently arched, not quite as wide as widest part of prothorax, nontuberculate (even behind shoulders); with regular rows of large punctures, appearing much smaller through clothing. Basal segment of abdomen slightly convex across middle, but depressed at base and middle of apex. Front coxae conspicuously separated, the distance between them being slightly more than half of that between the middle ones; tibiae moderately long, under surface granulate or subdenticulate. Length, 5–6 mm.

♀. Differs in having a somewhat smaller rostrum, shorter antennae, wider elytra and evenly convex abdomen.

Queensland: Stanthorpe (H. J. Carter).

In the 1926 table of the genus could be placed in G *u*, and from the species associated there it differs from *M. crawfordi* in being considerably larger, with coarser prothoracic sculpture and part of abdomen concealed by clothing; *M. transversus* has apical slope of elytra subtuberculate, and *M. setosus* has the third interstice on each elytron subtuberculate and slightly produced at the base, so that the base of the elytra is distinctly trisinuate; on the present species the base, as seen directly from above, is evenly arched, and there are other slight differences in the legs and clothing. A second male has most of the under parts decidedly reddish, probably from immaturity. The fringe on the hind tibiae of the male is longer than on the others. The disc of the prothorax is traversed by numerous impressed lines, separating irregular carinae, true granules are absent, but on the sides, invisible from above, there are numerous fairly large punctures and no ridges.

MANDALOTUS FEMORALIS, n. sp.

♂. Dark brown, legs and antennae paler. Densely clothed with brownish-grey, or muddy-grey, slightly variegated scales; interspersed with numerous sloping setae, mostly pale on the upper surface and legs, entirely so on the under surface.

Rostrum comparatively short, median carina narrow and distinct throughout. Antennae rather long and thin. Prothorax almost as long as wide, sides evenly rounded, base not much wider than apex, closely covered with round, flattened granules, traceable through clothing. Elytra subparallel-sided to beyond the middle, base trisinuate, and no wider than widest part of prothorax, nontuberculate; with rows of large punctures, almost concealed by clothing. First segment of abdomen depressed at base. Front coxae distinctly but not widely separated, the distance between them at the narrowest about half that between the middle pair; middle coxae each with a small acute tooth touching the trochanter; femora stout, the front pair much stouter than the others; front tibiae flattened and dilated, apical half with a rounded outline; near apex fully twice as wide as the others at a similar position. Length, 5 mm.

♀. Differs in having the rostrum smaller, antennae shorter, elytra wider in proportion, abdomen evenly convex, legs unarmed and femora less stout (the front pair scarcely as stout as the hind ones of the male).

Queensland: Wyreema (O. W. Tiegs). Types in Queensland Museum.

There is a minute tooth on the hind tibiae, close to the lower apex, so the species might be considered as having those tibiae armed, and thus associated in the 1926 table with *M. fergusoni*, but on that species the hind tibiae are bidentate, and the middle coxae unarmed. Passing that species in the table, it could be associated with *M. tibialis*, but the front tibiae are not conspicuously dentate near base, are wider and flattened on the apical half, and the tooth on each middle coxa is less prominent. The derm of the female is darker than that of the male, and it is probable that on mature specimens of both sexes it is mostly black. The elytral setae are confined to a single row on each interstice, and are almost as regular on the even as on the odd ones.

Leptops gladiator Lea.

Several specimens, from Tooloom (New South Wales), in the Queensland Museum, are larger than the types, and they all have some green scales on the muzzle and antennae, with the sides of the elytra more widely covered with white scales; between the largest tubercle on each elytron and the apex, they all have a small conical tubercle (not represented on the types). One female has a small additional tubercle in the outer row on the right elytron, another has a small additional one on each side, and another has two small additional ones on the right side, and three on the left.

Eurychirus obtusatus, n. sp.

Dull reddish-brown, antennae paler, parts of under surface infuscated. Densely clothed with fawn-coloured or light-brown scales, in places with a somewhat golden gloss; a blackish or dark brown fascia traversing the summit of the apical slope (including the two large tubercles) and becoming paler and wider towards the sides; under parts with whitish scales, in places with a faint golden or greenish gloss.

Head with small crowded punctures and a shallow interocular impression. Rostrum (excluding mandibles) about as long as wide, with a feeble median carina and crowded, partly concealed punctures. Two basal joints of funicle moderately long, the others transverse. Prothorax slightly wider than long, sides gently bisinuate, base slightly wider than apex; with crowded, partly concealed punctures. Elytra much wider than prothorax, shoulders thickened but not tuberculate; with series of rather large and deep punctures in shallow striae, third interstice with a large obtuse tubercle crowning the apical slope, fifth with a much smaller one (forming the preapical callus). Legs long, femora edentate and subclavate. Length, 5–6 mm.

New South Wales: Dorrigo and Ulong (W. Heron), Blue Gum Knob, in September (A. Musgrave), Upper Williams River, in October (F. E. Wilson and A. M. Lea).

Smaller than *E. alleni*, somewhat narrower, shoulders nontuberculate and median tubercles of elytra smaller, more obtuse and usually traversed by a fascia of black scales; *E. bituberculatus* is a still larger species. On some specimens the golden scales form a feeble V on the elytra, and still more feeble vittae on the pronotum.

Genus Rhinaria.

The species of this genus may be readily divided into two groups as follows:

1. Rostrum concave along middle.
2. Rostrum convex in middle.

In the first group the rostrum is usually carinated along the middle, but its sides are elevated so that it appears to be bisulcate; in the second group the sides in the middle rapidly slope downwards from a median ridge.

Group 1. Rostrum concave along middle.

bisulcata Lea.
carinirostris, n. sp.
caudata Lea.
cavirostris Pasc.
concavirostris Lea.
fasciata Pasc.
grandis Lea.
grisea Boisd.
interrupta Lea.
longirostris Lea.
signifera Pasc.
stellio Pasc.
sulcirostris Lea.
transversa Boisd.
= *myrrhata* Pasc.

Group 1. Rostrum concave along middle (*continued*).

debilis Blackb.
diversa Pasc.
elegans Lea.
faceta Pasc.
maculiventris Lea.
nigrivitta, n. sp.
perdix Pasc.
pulicosa Lea.
variegata Boh.
= *maculosa* Fhs.

Group 2. Rostrum convex in middle.

aberrans Lea.
caliginosa Pasc.
convexirostris Lea.
cristata Kirby.
= *simulans* Lea.
favosa Lea.
foveipennis Pasc.
granulosa Fhs.
= *costata* Er.
rugosa Boisd.
= *lopha* Gyll.
tessellata Pasc.
tibialis Blackb.
tragocephala Lea.

Group ?. Rostrum not mentioned in description.

excavata Boisd.

Rhinaria transversa Boisd.
(*R. myrrhata* Pasc.)

R. transversa is a well-marked species, with bright markings on fresh specimens, but with age the paler markings become greyish. It is the same species subsequently named *R. myrrhata* by Pascoe, and it occurs in New South Wales, Victoria, Tasmania and South Australia.

Rhinaria cristata Kirby.
(*R. simulans* Lea.)

A fairly common species in New South Wales, Victoria, and South Australia. As with others of the genus the scales are liable to alteration with age, immersion in alcohol, etc. *R. simulans* is now first recorded as a synonym.

Rhinaria variegata Boisd.
(*R. maculosa* Fhs.)

Recorded by Boisduval from New Guinea, but, as noted by Pascoe, on the plate as from "Port au Roi Georges", no doubt King George Sound. In Masters' Catalogue *R. maculosa* is given as a synonym.

Rhinaria caliginosa Pasc.

In commenting on this species Blackburn (Proc. Linn. Soc. N.S.W., 1892, 135) wrote: "There does not seem to be much doubt that this species is either *R. rugosa*, Boisd., or *R. excavata*, Boisd., and it appears to me very probable that they are two names for one species"; and on the following page: "If *R. excavata*, Boisd., be really distinct from *R. rugosa*, Boisd., it becomes a question whether it is not the same thing as *R. foveipennis*, Pasc. . . .". I cannot find any subsequent references to these names by Blackburn, but in his collection a specimen from Shoalhaven is labelled as *R. rugosa*, and is the unusually wide species generally accepted as such (= *R. lopha* Gyll.). It is black, with greyish clothing, having a slightly spotted appearance, and the rostrum longitudinally convex along middle. Two specimens, labelled by him as *caliginosa*, certainly do not belong to *rugosa*, but are females of the species he named *R. tibialis*. The species in my own collection, identified with a query as *caliginosa*, appears to be a slight variety of *tibialis* (if correct, the latter name must fall).

Rhinaria rugosa Boisd.

In the original description the rostrum is not even mentioned, but (as mentioned under the preceding species) the name is attached to a well defined species, common about Sydney.

Rhinaria tibialis Blackb.

A specimen, from Southern Queensland, may belong to this species, but is unusually large (16 mm., including the rostrum), with the outer apex of the front tibiae produced into a conspicuous, glabrous spur, much more pronounced than usual.

Rhinaria excavata Boisd.

As the rostrum of this species was not even mentioned in the original description, I do not think it could be positively identified without further information about the type (probably in the Paris Museum). Blackburn's remarks about the species, under *R. caliginosa*, cannot be regarded as more than a guess.

Rhinaria elegans Lea.

Three specimens, from South Australia, are larger (12–13 mm.) than usual, and have the conjoined front of the interocular crests projecting conspicuously forwards as a glabrous tubercle over the base of the rostrum, from which it is separated by a deep constriction. On several other South Australian specimens, however, including some from Kangaroo Island, the projection is much less conspicuous.

Rhinaria nigrivitta, n. sp.

Blackish-brown, some parts obscurely diluted with red. Densely clothed with rusty-brown scales, becoming whitish on scutellum, sides, and under surface, each elytron with a black or dark brown vitta in the fifth stria, for a little more than its median third.

Head with interocular crest curved on the sides and narrowly impressed along middle, its front with the base of a carina continued on to rostrum. Rostrum shallowly grooved on each side of middle, with a few long setae or bristles. Prothorax about as long as wide; with large, partly concealed punctures, each containing a seta, and with numerous small granules. Elytra much wider than prothorax; with rows of large, partly concealed punctures in wide shallow striae; alternate interstices feebly elevated, a few granules on suture near base. Length, 7·5–13·5 mm.

South Australia: Ardrossan (J. G. O. Tepper), Lucindale (B. A. Feuerheerdt). New South Wales: Blue Mountains, in September (A. Musgrave), K.37264 in Australian Museum.

On the pronotum, parts of the sides have irregular white markings, the median line is not white, but is paler than the adjacent parts; the conspicuous black vitta, in the fifth stria on each elytron, is the inner boundary of the lateral whitish scales, it is feebly connected with a small dark spot near the apex of the third stria. On the legs some of the scales have a golden-red gloss. On the elytra there is a row of setae on each interstice and some of these proceed from minute granules, but granules, except for a few sutural ones, at first glance appear to be quite absent from the elytra. The specimen from the Blue Mountains is much larger than the others, is more brightly coloured, and the vitta in the

fifth stria is distinctly connected with the small subapical spot, and has a short inner projection at the basal fourth.

RHINARIA CARINIROSTRIS, n. sp.

Black or blackish-brown, some parts obscurely diluted with red. Densely clothed with rusty-brown or ferruginous scales, variegated with paler ones, mostly pale on metasternum and abdomen.

Head with a strong, curved, squamiferous and setiferous crest, notched posteriorly, in front with a stout polished carina, curved downwards and continued on to rostrum. Rostrum bisulcate, sides rather strongly elevated; median carina distinct throughout; with numerous bristles. Prothorax about as long as wide, sides strongly rounded; with large, partly concealed punctures, each containing a seta, each discal puncture with a small granule at its back. Elytra much wider than prothorax; with rows of large punctures in wide striae; interstices with series of small granules, many of which are setiferous, odd interstices slightly elevated above the even ones. Length, 12–13 mm.

New South Wales: Dorrigo (W. Heron). Type in South Australian Museum; cotype, K 43607, in Australian Museum.

A comparatively wide species, with markings somewhat as on old specimens of *R. transversa* Boisd. (*R. myrrhata* Pasc.) and with similar interocular crests, but the carina proceeding from the front of the crests is much wider than on that species, highly polished, and conspicuously bent downwards in its middle. There is a broad stramineous (scarcely whitish) vitta on each side of the prothorax, continued on to head and on to sides of elytra, mesosternum and metasternum; somewhat similar scales form an obscure postmedian fascia on the elytra, a more obscure antemedian one, and still more obscure scattered spots, but many of the scales have a golden gloss in certain lights; the scales on the scutellum are almost white.

TRANES INSIGNIPES, n. sp.

♂. Dark castaneous-brown; head, rostrum, a narrow space at apex of prothorax and another at base, scutellum, a narrow space at base of elytra and an irregular median fascia, parts of under surface and legs (except tarsi) black. Sparsely clothed with short setae, becoming dense on metasternum and two basal segments of abdomen, apical segment with rather long, dense setae; three small white spots at base of prothorax and numerous others on elytra; all tibiae with long and dense, reddish-brown hairs.

Head with small dense punctures, and a fairly large interocular impression. Eyes almost meeting on lower surface. Rostrum long (slightly longer than prothorax) and moderately curved; with dense punctures, about base as large as on head, but smaller and sparser elsewhere; sides of under surface finely serrated in front of antennae (these inserted slightly nearer base than apex). Prothorax flattened, apex tubular; base with three small foveae, with a narrow, shining, impunctate median line; with numerous small punctures, becoming larger and mixed with granules on the sides of the upper surface, and on the outer walls. Elytra scarcely as wide as widest part of prothorax, punctate-striate, the interstices with numerous small punctures, and some larger ones. Prosternum excavated in front, the excavation with fine transverse striae, and bounded posteriorly by a conspicuous overhanging ridge (the insect viewed on its back). Length, 10–13 mm.

♀. Differs in having the rostrum shorter, prothorax smaller, its greatest width less than width of elytra, prosternum depressed along middle, the transverse striae less evident, and without the conspicuous ridge of the male metasternum and abdomen sparsely clothed, and tibiae feebly fringed.

Queensland: South Johnstone River (H. W. Brown). Types in South Australian Museum; cotype in Queensland Museum.

Very distinct from all other Australian species of the genus by the strong transverse ridge of the prosternum, and the long hairs on the tibiae; the former character might be regarded as of generic importance, but is confined to the male. *T. vigorsi* has conspicuous clothing on the under surface of the front tibiae only of the male. The black median fascia on the elytra is interrupted at the suture, and on some specimens is broken up into irregular spots. The spots of white clothing are numerous on the elytra, but the largest is scarcely the size of the scutellum (which, itself, is normally clothed with white pubescence, although on most of the specimens under examination this has been partly abraded). The conspicuous clothing on the tibiae of the male appears to project equally all round, but on examination its upper surface is seen to be glabrous, although normally concealed. The femora of the male are stout, and from some directions appear to be rather feebly dentate.

Tranes subopacus, n. sp.

Black or blackish, elytra, antennae, parts of under surface and tarsi, dull castaneous-brown. Upper surface glabrous, lower surface very sparsely clothed, tibiae each with a short fringe on lower surface.

Head with small and fairly dense punctures, with a shallow interocular impression. Eyes almost meeting on lower surface. Rostrum thin, slightly longer than prothorax, gently curved; with crowded and rather coarse punctures on basal fifth, sparse and minute elsewhere. Antennae inserted slightly nearer base than apex of rostrum. Prothorax somewhat flattened, sides rounded, apex about half the width of base; with crowded punctures of moderate size, many longitudinally or obliquely confluent, but leaving a narrow median line; elytra punctate-striate, the interstices with small punctures and obtuse granules. Under surface with rather dense, sharply defined punctures. Two basal segments of abdomen with a shallow median depression, the apical one with an almost round fovea occupying the median third. Femora stout, acutely dentate. Length, 8·5 mm.

Queensland: Byfield (H. J. Carter).

A subopaque species, at first glance apparently belonging to *Tyrtaeosus*, of the Cryptorhynchides, but the prosternum is not channelled. Some parts are quite black, but on close examination the head and prothorax are seen to be obscurely diluted with red. The elytral interstices appear to have series of obtuse granules, but this appearance is mostly due to numerous transverse impressions. Judged by the clothing of its tibiae the type appears to be a female.

Tranes prosternalis, n. sp.

♂. Reddish-castaneous, rostrum (tip obscurely diluted with red), a spot on each side of base of prothorax, extreme base, shoulders and some irregular median spots on elytra, and legs (except tarsi) black. Rather sparsely clothed with white setae, becoming dense on scutellum; front tibiae conspicuously fringed on lower surface with long reddish hairs, the others less noticeably fringed.

Head with small punctures becoming larger (but not very large) in front, with a small interocular fovea. Eyes slightly separated on lower surface. Rostrum thin, slightly longer than prothorax, gently curved; with fairly dense punctures of moderate size about base, becoming much smaller elsewhere. Antennae inserted slightly nearer apex than base of rostrum. Prothorax about as long as wide, disc slightly convex, sides rounded, apex about half the width of base; with dense but not crowded punctures of moderate size, leaving a narrow, shining median line. Elytra oblong-cordate, slightly wider than prothorax; punctate-striate, interstices finely wrinkled and with sparse punctures. Prosternum with a flattened setose space in front of coxae (triangularly produced between the coxae themselves), its tip obtusely pointed in front. Two basal segments of abdomen with a wide and shallow median depression. Femora stout, distinctly dentate, tibiae moderately curved. Length, 6·5 mm.

Queensland: Endeavour River (C. French, Sr.).

In general appearance approaching *T. sparsus*, but prothorax and elytra with black markings, and prosternum with a median projection close to apex, instead of one on each side of apex. There are three or four irregular subsutural spots on the middle of the elytra, but they are asymmetrical on each of the two specimens before me. The elytral setae are nowhere dense, but being absent from parts the elytra have a feebly fasciate appearance. The setose space on the prosternum appears fringed with slightly longer setae on the sides than in the middle and its point is glabrous (almost dentiform).

Table of most Australian species of Tranes.

A. Black.
  a. Femora edentate ..... *roei* Boh.
  aa. Femora dentate.
    b. In life with a white exudate ..... *insularis* Pasc.
    bb. Without such ..... *xanthorrhoeae* Lea.
AA. Upper surface partly or entirely red.
  B. All tibiae of male with long bristling hairs ..... *insignipes*, n. sp.
  BB. Front tibiae only of male with a conspicuous fringe on lower surface.
    C. Prosternum of male with a medio-apical process ..... *prosternalis*, n. sp.
    CC. Prosternum of male with a short spine on each side of apex ..... *sparsus* Boh.
    CCC. Prosternum of male simple in front ..... *vigorsi* Boh.

Species not included in table.

subopacus, n. sp. Not included, as the type is probably a female, but very distinct from the other partly red species, by the sculpture of its prothorax and elytra.

monopticus Pasc. A black species with fuscous elytra and remarkable eyes, "the facets being freely interposed on both sides". On several species the line of division of the eyes is very inconspicuous with the head in position, and could easily be altered in appearance by a slight displacement of clothing.

internatus Pasc. I have had a species in my collection for many years (named after comparison with specimens in the Macleay Museum) as *T. internatus*, but it differs from the description in having the femora dentate (the teeth partly obscured by the clothing) and the elytra as black as the prothorax. In general appearance it is close to *T. roei*, but has coarser punctures and numerous small granules on the apical slope of the elytra, *roei* also has stout but truly edentate femora.

RHINOTIA PARVA Lea.

A specimen, from Bunya Mountain, in the Queensland Museum, probably belongs to this species, but differs from the type in having only about one-fourth of the apex of the elytra black, and the prothorax with an almost continuous vitta of pubescence on each side, red in front and almost white behind.

Genus EUOPS.

The sexes of species of this genus may be readily distinguished, the male has the front tibiae long and falcate, those of the female are shorter, less curved and with a median projection or wide notch on the under surface. The male sometimes has a depression on the abdomen, margined with fascicles, or simply flattened in the middle; on the female the abdomen is strongly and evenly convex and three segments have double transverse series of white setae across the middle; on some species the following segment has a single series. The head is usually longer on the male than on the female, and his eyes are usually larger.

EUOPS EUCALYPTI Pasc.

A specimen from the Dividing Range (Victoria), possibly represents a variety of this species; it differs from the typical form in having the prothoracic punctures much smaller, and those on the metasternal episterna comparatively sparse and somewhat smaller, on the typical form they are crowded and rather coarse.

EUOPS STRIGIVENTRIS Lea.

Four specimens, sexes, from Gosford (New South Wales) differ from the typical form in having the scutellum brassy instead of green.

EUOPS CORRUGATA Lea.

A specimen from Mount Tambourine (Queensland) evidently belongs to this species, but is slightly larger than the type, and the prothorax is slightly more metallic, although not at all greenish.

EUOPS SUTURALIS Lea.

A specimen from the Blackall Ranges (Queensland) may represent an extreme variety of this species; at first glance its elytra appear to be entirely black, but on close examination a small space on each side at the basal third appears to be obscurely diluted with red.

EUOPS SPISSUS, new name.
(*E. puncticollis* Lea, n. pr.)

The name *E. puncticollis* was used by Boheman in 1859, and has been recorded as a synonym of *E. falcata*. Unfortunately I again used the name in 1898, and now have to propose the above substitute. The species occurs in North Australia (Melville Island) and Queensland (Cairns, Mount Tambourine and Imbil) as well as in New South Wales. The specimens from Imbil were taken from the stomach of a "fly-catcher", but are in quite recognizable condition. The male differs from the female in having the front femora longer and stouter, the front tibiae longer, thinner and strongly curved, and the abdomen with a fairly large median depression.

EUOPS PARVOARMATA, n. sp.

♀. Reddish, elytra (suture and base narrowly excepted) purplish-brown, basal joint of antennae and club blackish. Three basal segments of abdomen each with a double transverse series of white setae in middle, the fourth with a single series.

Head with sparse and small punctures, but with a few larger ones immediately behind eyes. Eyes large and touching for a short distance. Rostrum dilated to apex; with numerous small punctures. Prothorax moderately transverse, evenly convex, with a narrow impression near apex and another near base; with punctures of moderate size and fairly numerous on sides, much smaller elsewhere. Elytra widest across shoulders, which are strongly rounded, but each with a small pointed lateral process, sides feebly diminishing in width posteriorly; with rows of comparatively small separated punctures, becoming smaller posteriorly, the interstices with minute punctures and very feebly wrinkled. Metasternum with coarse crowded punctures, becoming sparser but no smaller on episterna. Pygidium with crowded punctures, somewhat smaller than on metasternum. Front tibiae comparatively long and thin, finely serrated on under surface, notch feeble. Length, 3·5–4·0 mm.

Queensland: Brisbane (R. Illidge), Mount Tambourine (A. M. Lea).

Very distinct by its colours and shoulders, the latter being slightly armed, but not as in *E. tuberculata*.

EUOPS QUADRIFASCICULATA, n. sp.

♂. Dark brown or blackish, with various metallic glosses, legs obscurely reddish, with a bluish or greenish gloss.

Head finely transversely strigose and with small punctures, becoming fairly large immediately behind eyes. Eyes large and almost touching. Rostrum moderately dilated to apex, with sparse punctures. Prothorax almost as long as the basal width, which is much greater than that of apex, densely and finely strigose except near base; with a deep, curved, sub-basal impression, and with an interrupted depression across middle; with rather coarse punctures on sides, invisible from above. Elytra not much longer than wide, with rows of large punctures, in well defined striae. Metasternum and pygidium with crowded punctures. Abdomen with a large median depression bounded on each side by two tubercles crowned by long white fascicles, sides with sparse punctures and rather feebly obliquely strigose. Femora stout, front tibiae long, thin, and strongly curved. Length, 1·75–2·00 mm.

♀. Differs in having the head slightly shorter, the abdomen strongly convex, each of the three basal segments with a transverse double row of setae, the femora thinner and the front tibiae shorter, somewhat stouter, and with a shallow notch or incurvature on the lower surface.

Northern Queensland (Blackburn's collection).

Structurally close to *E. corrugata*, but brighter and more metallic. The head and base of rostrum and parts of the under surface have a conspicuous greenish gloss, on other parts the gloss is faintly green, or brassy or bronzy; the pygidium is more or less brassy or golden. Several females have the elytra purplish-brown, with a slight bronzy gloss, on one of them the scutellum is green. On one of the females the median impression of the pronotum is complete, on two others, and on the male, it is incomplete. The abdominal fascicles of the male are conspicuous.

Three males (also from Northern Queensland in the Blackburn collection) probably belong to this species; they differ, however, from the type male in having the pronotum very feebly strigose, and the median impression altogether absent. They are mostly blackish, but the abdomen and other parts of the under surface and the legs are obscurely reddish; on two of them the head immediately behind the eyes and the metasternum are greenish; the third is more bronzy, and its head is bronzy-green; parts of the under surface have a bluish gloss. On all of them the pygidium is coppery. The abdominal excavation and its marginal fascicles are exactly as on the type.

Euops episternalis, n. sp.

♂. Black, most parts of upper surface with a faint purplish gloss, most parts of under surface with a greenish gloss, scutellum metallic blue.

Head with coarse punctures behind eyes, and on the sides, basal half finely transversely strigose. Eyes large and scarcely visibly separated. Rostrum strongly dilated to apex, and with distinct punctures on sides. Prothorax slightly longer than basal width, which is much greater than that of apex; disc with sparse and rather small punctures, but some larger ones in a curved basal impression, and larger and denser ones on sides. Elytra with sides feebly diminishing in width from beyond shoulders; with rows of large, deep punctures, becoming smaller posteriorly, interstices impunctate. Metasternum with coarse punctures, becoming sparse on episterna. Abdomen slightly flattened in middle, with irregular punctures, and in places obliquely strigose; pygidium with dense, punctures, slightly smaller than on metasternum. Front femora longer and stouter than the others; front tibiae long, thin, strongly curved, and finely serrated on under surface. Length, 3·00–3·25 mm.

♀. Differs in having the head shorter, eyes less prominent, the depression behind them shallower, prothorax slightly shorter, three segments of abdomen each with two transverse rows of white setae, front femora smaller, and front tibiae shorter, less curved and under surface feebly bisinuate.

Northern Queensland (Blackburn's collection): Cairns (E. Allen, J. A. Anderson, and A. M. Lea), Thursday Island (N. B. Tindale).

Fairly close to *E. postocularis*, but elytral punctures much larger, those at the apex being almost as large as those at the base of that species, the punctures on the metasternum and sides of the prothorax are larger, and those on the disc of the former more distinct. On several specimens the shoulders as well as the scutellum are bluish. On one male the scutellum and the front coxae are of a brilliant green; on one female the scutellum scarcely differs in colour from the adjacent parts. On four specimens, sexes, the pronotum has no trace of a median transverse impression, but on four others (also sexes) remnants of such an impression may be traced.

Euops coxalis, n. sp.

♂. Black, legs obscurely diluted with red; scutellum, shoulders, and front of front coxae brilliant metallic green.

Head rather long, transversely strigose at base, elsewhere with well defined punctures. Eyes slightly separated. Rostrum strongly dilated to near apex, with rather small punctures. Prothorax slightly longer than the basal width, which is about one-fourth greater than that of apex, with a narrow transverse impression

near apex, a curved one near base, and a shallower one across middle; with small, scattered punctures, becoming larger and more numerous, but not crowded, on sides. Elytra much wider than prothorax, sides decreasing in width beyond shoulders, a shallow depression extending across four interstices on each side of suture near base; with rows of fairly large punctures, becoming smaller posteriorly, interstices impunctate or almost so. Abdomen with a large, shallow, median depression, finely obliquely strigose and with scattered punctures; pygidium with numerous sharply defined but not crowded punctures. Metasternum with sharply defined ones, becoming irregular on episterna. Front femora long and stout, front tibiae long, strongly curved and finely serrated on under surface. Length, 3·5–4·0 mm.

♀. Differs in having the head shorter, prothorax slightly shorter than its basal width, abdomen strongly convex, three segments each with a double series of white setae across middle, the fourth with a single series, front femora smaller, and the front tibiae shorter, stouter, and the lower edge straight, except for a subapical incurvature.

New South Wales: Dorrigo (W. Heron).

In general appearance fairly close to *E. strigiventris*, but prothorax with a distinct transverse median impression, rostrum distinctly shorter, and abdomen with clothing on four segments instead of on three. The prothoracic punctures are much smaller than on *E. eucalypti*, which also is without the three brilliant green spots on the upper surface. It is wider than *E. clavigera*, and the prothorax is different. On some specimens there is a bluish gloss on parts of the under surface.

EUOPS CONTACTA, n. sp.

♂. Black with a faint bluish or purplish gloss, becoming greenish on parts of under surface.

Head with a conspicuous depression behind eyes, on the front of which there are sharply defined punctures, the sides punctate and strigose. Eyes large, in contact for much of their length. Rostrum dilated to apex, sides with a few punctures. Prothorax almost as long as the basal width, which is almost twice that of apex, with a curved impression near base, and remnants of a feeble median one; disc with small, scattered punctures, becoming larger and coarser on sides. Elytra much wider than prothorax, feebly diminishing in width posteriorly; with rows of large punctures, becoming smaller towards apex, interstices very minutely punctate. Metasternum with coarse punctures, absent from front half of each episternum. Abdomen slightly flattened in middle, densely and finely obliquely strigose, and with scattered punctures; pygidium with crowded ones. Front femora longer and stouter than the others, front tibiae long, thin, strongly curved and finely serrated on the under surface. Length, 3 mm.

Queensland: Babinda (Dr. J. F. Illingworth); unique.

The eyes are actually in contact for a considerable part of their length, a character at once distinctive from *E. eucalypti*, which otherwise, except that the punctures are smaller, the species much resembles. *E. strigiventris* has a longer head, and eyes nowhere in contact. Most of the upper surface of the head is impunctate.

EUOPS MICANS, n. sp.

♂. Brilliant greenish-blue; legs blackish.

Head with sharply defined but somewhat irregular punctures, becoming coarse just behind eyes. Rostrum with scattered punctures. Prothorax almost as long as the basal width, which is almost twice that of apex, with numerous rather small, but sharply defined punctures, becoming larger on sides and in a curved subbasal depression. Elytra oblong-cordate; with rows of large, deep punctures, becoming smaller posteriorly, interstices with small scattered punctures. Metasternum (including episterna) with crowded punctures. Abdomen closely obliquely strigose and with numerous punctures, two basal segments with a wide and shallow median impression. Femora stout, front tibiae thin, rather long, moderately curved and finely denticulate on under surface. Length, 2·5–3·0 mm.

♀. Differs in having less prominent eyes, abdomen convex, three basal segments of abdomen each with a double transverse series of white scales in middle, the following one with a single series; front tibiae shorter and stouter, bisinuate on lower surface and not denticulate.

Queensland: Stanthorpe, in January (H. J. Carter); New South Wales: Barraba (W. du Boulay).

Structurally close to some small specimens of *E. eucalypti*, except that the prothoracic punctures are smaller, but of a brilliant blue; one female is of a decided coppery-green. The pronotum is without remnants of a transverse median impression.

Storeus magnus, n. sp.

♂. Blackish-brown, some parts black, antennae, tarsi and part of rostrum obscurely reddish. Densely clothed with rusty-brown, slightly variegated scales, interspersed with numerous setae.

Rostrum slightly longer than prothorax, slightly curved; with acute ridges alternated with rows of punctures to apical fourth, where the antennae are inserted, in front with small, sharply defined punctures. Prothorax strongly transverse, sides moderately rounded, in front subtriangularly produced over head; with crowded, normally concealed punctures. Elytra subcordate, base strongly trisinuate and wider than prothorax, sides rounded; with regular rows of large punctures. Under surface with dense punctures, except near hind coxae, behind each of which there is a row of large ones. Prosternum with a deep pectoral canal, peep-holes well-defined and semidouble. Femora stout, rather strongly and acutely dentate, tibiae with a fasciculate swelling at the outer base, smaller but more distinct on the front pair than on the others; claws strongly appendiculate. Length, 4·5 mm.

Queensland: National Park, in November (H. Hacker). Type (unique) in Queensland Museum.

A wide species, in general appearance fairly close to *S. specularis*, but each tibia with a tuft or fascicle of scales, somewhat as on *S. fasciculatus*, although otherwise not close to that species. On the elytra the setae (except for one in each seriate puncture) are almost confined to the odd interstices, and vary from whitish to dark brown, on the third they form two or three small fascicles, and a more distinct blackish one on the preapical callus on each.

Storeus squamipictus, n. sp.

♂. Dark reddish-brown, some parts almost black, antennae, parts of legs and tip of rostrum reddish. Densely clothed with variegated scales and setae, the under surface and legs with setae only.

Rostrum fairly stout, about the length of prothorax, slightly curved, with fine ridges, the median one rather feeble in front, alternated with rows of setiferous punctures to between antennae (these inserted at apical third), in front with small, elongated punctures. Prothorax moderately transverse, sides almost parallel to near apex, and then suddenly and strongly narrowed, the apex slightly produced over head; punctures dense and normally concealed. Elytra at base moderately trisinuate, and slightly wider than prothorax, sides rounded and gently dilated to beyond the middle; with rows of large, partly concealed punctures, the alternate interstices slightly elevated. Prosternum with pectoral canal short and deep, peep-holes deep and distinct. Abdomen wide, third and fourth segments combined slightly shorter than second or fifth. Femora acutely dentate, claws appendiculate. Length, 3·75 mm.

New South Wales: Tooloom in January (H. Hacker). Type (unique) in Queensland Museum.

A well marked and isolated species. The front tibiae are not dentate, but there is a slight swelling at the middle of the under surface, slightly more pronounced than on *S. acutidens* (which is a narrower and more elliptic species). On the pronotum most of the scales are pale, some almost white, with a large irregular blackish triangle resting on the base, and its tip almost at the apex; on the elytra there is a large blackish patch abruptly terminated just beyond the middle in the sutural region, elsewhere the scales are mostly pale brown, but on the apical half of the suture there are numerous small, whitish spots. The setae are mostly similar in colour to the scales amongst which they are set, but there are numerous white ones on the sides, and the preapical callus on each elytron has a short fascicle of black ones.

STOREUS PREAPICALIS, n. sp.

♂. Reddish-brown, parts of under surface darker, antennae and parts of legs paler. Densely clothed with soft, whitish-brown scales, slightly variegated on upper surface, paler and uniform on under surface and legs; a few setae scattered about.

Rostrum not very stout, about the length of prothorax, moderately curved, with fine ridges alternated with rows of punctures to apical third (where the antennae are inserted), in front with numerous small but sharply defined punctures. Prothorax strongly transverse, sides moderately rounded, but apex suddenly narrowed; with crowded, normally concealed punctures. Elytra distinctly wider than prothorax, base strongly trisinuate, sides almost parallel for a short distance, and then decreasing to apex; with rows of large, almost concealed punctures, interstices almost even throughout, but each elytron with a fairly large, obtuse, preapical callus. Prosternum with a short, deep, pectoral canal, peep-holes angular and distinct. Abdomen with third and fourth segments combined slightly longer than second, and shorter than fifth. Legs comparatively long and thin, femora edentate, claws strongly appendiculate. Length, 3·5 mm.

Queensland: National Park in November (H. Hacker). Type (unique) in Queensland Museum.

The elytral tubercles are in the same positions as on the preceding species, but the femora are edentate, the rostrum is almost evenly curved throughout, and the clothing is very different. At first glance the clubs appear to be distinctly darker than the rest of the antennae, but this is due mostly to their clothing.

STOREUS ACUTIDENS Lea.

The types of this species were without a locality label. A specimen has recently been received from Stradbroke Island (Queensland).

STOREUS HYSTRICOSUS Lea.

A male from Mapleton (Queensland), in the Queensland Museum, is slightly larger than the type, and with the clothing more of a rusty-red, the small apical and subapical fascicles on the elytra have their setae rather loose, instead of compacted, as on the type. A specimen from the Upper Williams River (New South Wales), in the collection of Mr. F. Erasmus Wilson, has clothing as on the Mapleton one, but is a female, and differs from the male in having the rostrum longer, thinner, more curved, with sparse setae only on the basal half, and the abdomen more evenly convex.

PERISSOPS SQUAMIVARIUS, n. sp.

♂. Black, antennae and tarsi reddish. Irregularly clothed with scales, mostly buff-coloured, and with some black, velvety spots on elytra.

Head with sparse and small punctures and a feeble interocular impression. Rostrum rather wide, scarcely the length of prothorax, feebly curved, sides feebly incurved to middle; basal half with crowded squamiferous punctures, elsewhere with numerous small, and sharply defined, naked ones. Antennae inserted one-third from apex of rostrum, scape the length of funicle, club elliptic-ovate, the length of six preceding joints combined. Prothorax moderately transverse, sides strongly rounded, apex about half the width of base; with rather small and very small punctures on disc, but larger and deeper ones on sides. Scutellum distinct. Elytra with outlines subcontinuous with those of prothorax, almost parallel-sided to beyond the middle, base trisinuate, the median sinus deeper than the others; with rows of large, setiferous punctures, becoming smaller posteriorly; with minute granules on the first and second interstices, becoming dense on the third on its basal fourth. Metasternum with fairly large punctures on sides, but small on episterna, on which they form a single row in middle, but are somewhat crowded at the ends. Femora stout, rather strongly dentate, tibiae compressed. Length, 6 mm.

♀. Differs in having the rostrum thinner, with squamiferous punctures only on each side of base, elsewhere almost impunctate, and antennae inserted slightly more distant from apex.

Queensland: National Park in November (H. Hacker). Types in Queensland Museum.

An elongate-elliptic species, about the size of, and without lines much as in *P. semicalvus* and *ochreonotatus*, but the interocular impression minute instead of very large. In the table of the genus (Lea, PROC. LINN. SOC. N.S.W., 1903, 644) it could be associated with *P. variegatus*, which is a much larger and otherwise very different species. The buff-coloured scales margin the eyes, form irregular spots on the prothorax, are dense on parts of the elytra, including the apical slope and form spots on the second to fourth segments of abdomen, and a spot in front of each front coxa; on the under surface and legs the clothing is mostly white, and there are some white setae on the upper surface; black scales are fairly numerous on the prothorax, but are indistinct; on each elytron there are two large, velvety-black patches, one near the middle of the base, the other just

beyond middle; in addition there are some irregular and much smaller patches half-way down the apical slope. The two basal segments of the abdomen are large and rather strongly convex in both sexes.

PERISSOPS PICTIPENNIS, n. sp.

Black, antennae and tarsi reddish. Densely clothed with variegated scales and setae.

Head with dense, concealed punctures, flat between eyes and not foveate there. Rostrum slightly curved, moderately thin, slightly longer than prothorax; with crowded punctures, coarse and squamiferous towards base, smaller and naked, but still rather dense, in front; and with a short, shining, median line. Antennae inserted two-fifths from apex of rostrum, scape the length of funicle, club elongate-ovate, the length of six preceding joints combined. Prothorax about twice as wide as long, sides strongly rounded, near apex rapidly narrowed and depressed, hind angles rounded off and received in latero-basal curvatures of elytra; with crowded punctures, each containing and concealed by a scale, but partly visible on sides. Scutellum distinct. Elytra slightly wider than widest part of prothorax, and fully thrice as long, sides parallel to beyond the middle; with rows of large, setiferous punctures, appearing much smaller through clothing, interstices almost even, except the third, which has an elongate granular elevation near the base. Under surface with fairly dense, but not coarse, squamiferous punctures, in about three rows on metasternal episterna. Femora rather stout, grooved and strongly and acutely dentate; tibiae compressed, at base rather strongly arched. Length, 7·5 mm.

New South Wales: Tooloom in January (H. Hacker). Type (unique) in Queensland Museum.

In the 1903 table of the genus this species could be associated with *P. brevicollis*, which is certainly its nearest ally, but it differs in being larger, with a conspicuous irregular whitish patch of scales on apical slope of elytra (its outer margin almost circular), prothoracic scales larger, third interstice of elytra more strongly elevated near base and front femora not quite as stout. The scales on the upper surface are mostly of a rather dark rusty-brown; on the elytra there is a large irregular patch of whitish scales on the apical slope, and small irregular spots elsewhere, there is a small velvety-black patch at the apex of the suture, and two smaller ones above it; there are also some small black (but not velvety) spots; on the pronotum the scales are mostly buff, with four feeble clusters of slightly darker scales, placed in a transverse row nearer apex than base, and sub-fasciculate in appearance, and with a few white scales scattered singly; on the under parts the scales are mostly white or pale buff. Judging by the punctures of its rostrum the type is a male, but the antennae are less close to the apex than is usual on that sex.

PERISSOPS ABACETUS, n. sp.

Blackish-brown, parts of antennae and of tarsi obscurely reddish. Irregularly clothed with soft, variegated scales.

Head with crowded punctures to between base of rostrum. Rostrum slightly curved, about the length of prothorax, sides feebly incurved to middle; with squamiferous punctures on sides near base, elsewhere shining, and with small, sharply defined punctures. Antennae inserted two-fifths from apex of rostrum, scape the length of funicle, club ovate, almost as long as six preceding joints

combined. Prothorax almost as long as the median width, sides strongly rounded, apex about half as wide as base; with crowded, more or less concealed punctures. Scutellum distinct. Elytra not much wider than prothorax, parallel-sided to beyond the middle, base gently trisinuate; with rows of large punctures, in places almost concealed by clothing; interstices gently separately convex, the third not specially elevated at base. Under surface with rather dense punctures, becoming fairly large on sides of metasternum, its episterna with irregular punctures, interrupted in middle. Femora stout, acutely dentate, tibiae rather short. Length, 4 mm.

Queensland: National Park (H. Hacker). Type (unique) in Queensland Museum.

A small and rather narrow, elliptic species, about the size of *P. parvus*, but with very different clothing, rostrum longer and thinner, eyes with somewhat smaller facets, antennae darker (the club is blackish), and femora thicker and more strongly dentate. The mesosternal receptacle is cavernous but very slightly so, and its walls are thin and rather widely U-shaped. Some of the scales have been abraded from the type; on the upper surface they are largely whitish, mixed with fawn-coloured or rusty ones, and with some ill-defined darker spots; on the prothorax there are four dark spots across the base, and one in the middle, on the elytra there are several on the apical slope and at its summit, and several about the base; on the under parts the scales are white, on the head they are mostly dark.

ATHYREOCIS TRIANGULIFER, n. sp.

♂. Black, rostrum, antennae and claw-joints more or less reddish. Densely clothed with light brown or buff scales, with a conspicuous black triangle on each elytron; in addition with numerous pale and dark setae.

Rostrum the length of prothorax, slightly curved, apical half glabrous; with sharply defined and fairly numerous punctures. Antennae inserted in middle of sides of rostrum, first joint of funicle elongate, second moderately long, the others short. Prothorax about as long as the basal width, which is about twice that of apex, sides gently rounded on basal two-thirds, more narrowed in front; with crowded, normally concealed punctures. Elytra closely applied to, and at base (which is gently trisinuate) no wider than base of prothorax, shoulders square, but sides dilated beyond them to slightly beyond the middle; with large punctures in striae; the striae appearing rather feeble through clothing, and the punctures (except on sides) almost or quite concealed; third interstice with two fairly large but obtuse tubercles, the first at the basal fourth, the second crowning the apical slope. Middle and hind femora feebly, the front ones very feebly dentate. Length, 4·2–4·5 mm.

♀. Differs in having the rostrum longer, thinner, clothed only on basal fourth, its punctures sparser and much less distinct, antennae inserted nearer the base of rostrum, prothorax slightly longer, abdomen more convex, and legs slightly shorter.

Queensland: National Park, in December (H. Hacker). Type in Queensland Museum; cotype in South Australian Museum.

The prothorax is longer than is usual in the genus. On this, and the following species, the scattered erect setae are less numerous than on the previously described ones. The club is darker than the rest of the antennae. The black triangle on each elytron is sharply defined on three specimens, and less so on two

others, its longest side commences on the shoulder, and runs obliquely to the postmedian tubercle, thence the shortest side runs straight to the lateral margin, which is narrowly polished for about half its length. The setae on the pronotum are numerous, but do not form fascicles; on the elytra, however, they are fasciculate on the tubercles. The elytral striae are well defined on the sides and traceable elsewhere, but their contained punctures (except on the sides towards the base) appear small, or are quite concealed, although often indicated by setae.

ATHYREOCIS SEMICIRCULARIS, n. sp.

♂. Blackish-brown; rostrum, antennae and claw-joints more or less obscurely reddish. Densely clothed with pale brown or buff scales, somewhat variegated on elytra, and mixed with short, stiff setae.

Rostrum rather wide, feebly curved, almost the length of prothorax, basal third densely clothed, elsewhere glabrous and with rather dense punctures, but leaving a feeble median line. Antennae inserted slightly nearer base than apex of rostrum, scape short, scarcely twice the length of first joint of funicle. Prothorax almost as long as the basal width, which is about twice that of apex, with crowded, normally concealed punctures. Elytra rather short, base almost truncate, and very little wider than prothorax, sides dilated to beyond the middle; third interstice with an obtuse fasciculate tubercle at the basal fourth. Legs short, femora feebly grooved and feebly dentate. Length, 3·5 mm.

Queensland: Bunya Mountains, in December (H. Hacker). Type in Queensland Museum.

There is a pale, but not white, semicircle on the elytra, crossing the suture, where it is most distinct, at the basal third, but vanishing before the shoulders; beyond it there is an irregular blackish one, which almost touches the sides. On the pronotum the setae are pale and dark, the latter are congested so as almost to form six feeble fascicles; on the elytra the dark ones form a short but conspicuous fascicle on the third interstice, and are fairly numerous on the dark semicircle, beyond this the pale ones are numerous and some of them form very feeble fascicles. The type was not partly abraded to examine the sculpture, but the striae are feebly indicated, except on the sides, where they are distinct, their punctures are mostly concealed, even on the sides. A female, from the National Park of Queensland, in December (H. Hacker), may belong to the species; its rostrum is slightly longer, thinner, more curved, with smaller punctures, antennae inserted nearer its base and abdomen more convex. The pale semicircle on the elytra is almost white, and is not followed by a black one. Dark setae are almost absent, even from the tubercle on the third interstice, and there appear to be also several very feeble tubercles crowning the apical slope, that are even less distinct on the type.

VARIATIONS IN CERTAIN ORCHIDS.

By The Rev. H. M. R. Rupp, B.A.

(Two Text-figures.)

[Read 30th October, 1929.]

1. Dendrobium speciosum Sm., var. gracillimum, n. var. Text-fig. 1.

Variations in *Dendrobium speciosum* are frequent and perplexing. Many of these, though occasionally departing widely from the type, are too inconstant to be satisfactorily defined. Even in regard to some forms already admitted to varietal rank, e.g., var. *Hillii* Hook., published descriptions do not always agree. The form for which the name var. *gracillimum* is here proposed, however, is so consistently distinct from the type, that it is difficult to resist an effort to secure its recognition not as a mere variety, but as a different species. I am only restrained from this by the fact that the flowers are indistinguishable from those of a plant which in all other respects is a characteristic *D. speciosum*.

The new variety may be described as follows: Stems from 22-40 cm. long, but rarely exceeding 12 mm. in diameter at the broadest part. Leaves 3-5, from 8-16 cm. long, oblong to broad-lanceolate, not very rigid, and with a tendency to recurve. Racemes 1 to 3, arising from either between or below the leaves, 10-25 cm. long. Flowers in the shorter racemes rather densely set, in longer ones scattered. Whole flower smaller, and segments always much shorter in proportion, than in typical *D. speciosum*, but conforming otherwise in structure and in the markings on the labellum. Colour white, cream, or greenish-yellow. Fl. September and October.—Valleys of the Paterson, Williams, and Clarence Rivers: also seen from other localities unspecified.

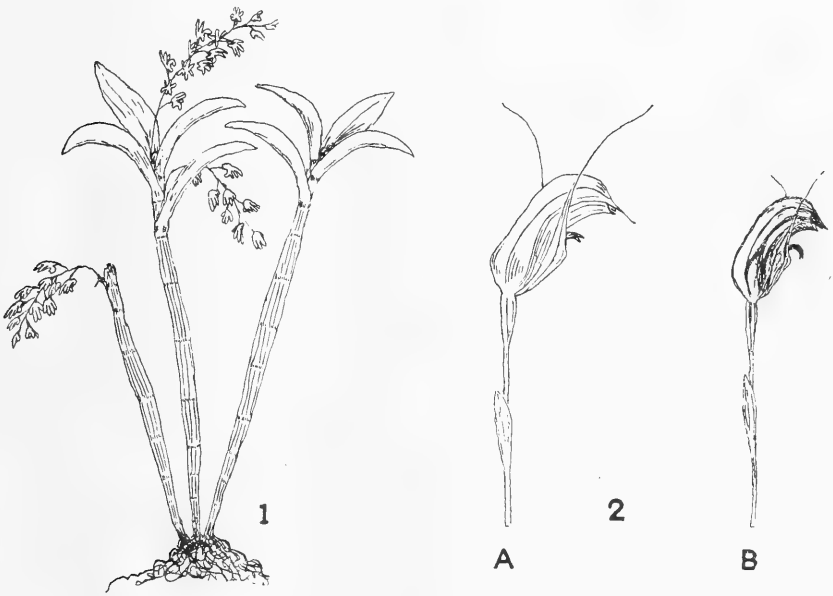
In general appearance the plant strongly suggests a giant form of *D. gracilicaule* F.v.M. I have alluded (*Aust. Nat.*, June, 1927) to the opinion of Dr. R. S. Rogers, to whom I had submitted specimens, that it is practically identical with the Lord Howe Island plant *D. gracilicaule* var. *Howeanum* (Maiden), of which I have seen only Fitzgerald's unpublished plate. Having had opportunity to observe the mainland plant both in its natural conditions and in cultivation, I found difficulty in accepting its inclusion under *D. gracilicaule*. I believe that its origin may be sought in hybridization between the latter species and *D. speciosum*, even though its relation to the Lord Howe plant may complicate this theory; but the flowers conform to *D. speciosum* far more closely than to *D. gracilicaule*. In 1928 I sent Dr. Rogers a living plant supplied by Mrs. J. D. Tucker, of Paterson. It flowered for him in October, and he wrote: "It has fully converted me to your view that its affinities are with *D. speciosum* rather than with *D. gracilicaule*, and that it should be regarded as a form of the former species." In the same month I had it flowering simultaneously with a very robust, stout-stemmed, rigid-leaved *D. speciosum*, the flowers of which were much smaller than is usual.

Having mixed three of these flowers in a box with three from the plant now under discussion, I was entirely unable to sort them out: identity appeared complete, notwithstanding the great differences between the plants.

This orchid is very attractive in appearance, and delightfully fragrant. Like *D. gracilicaule*, it flowers regularly every year—a characteristic often lacking in the typical *D. speciosum*—and is well worth cultivating. It seems to grow chiefly on trees, but in the Clarence River district it may often be seen on rocks with the type-form.

2. PRASOPHYLLUM INTRICATUM Stuart.

Tasmanian, South Australian and most Victorian specimens of this diminutive Prasophyll agree very closely. All differ considerably in appearance from the plant figured over this name by Fitzgerald. Stuart's type-form was Tasmanian, and to some observers it seemed possible that Fitzgerald's plant was a different



Text-fig. 1.—*Dendrobium speciosum* Sm., var. *gracillimum*, n. var. Much reduced.
Text-fig. 2.—A. *Pterostylis ophioglossa* R.Br.; type. (× ⅔). B. *Pterostylis ophioglossa* R.Br., var. *collina*, n. var. (× ⅔)

species. In the autumn of 1929 I obtained at Paterson a single specimen of a little Prasophyllum which I was able to compare with a Victorian *P. intricatum* growing in my fernery. They were obviously closely allied, but the Paterson flowers were smaller, darker, and far more numerous, with gland-tipped sepals and petals. I sent both to Dr. Rogers for inspection, and he expressed the view that the Paterson plant agreed with Fitzgerald's exposition of *P. intricatum*, and that the differences between the two, though striking, were not such as to require separation. I think there is no doubt about the former statement; and the differences between the two forms seem to me no greater than those between

northern and southern specimens of *P. nigricans* R.Br. The incidence of ciliation agrees, and both have the dark longitudinal bands on the labellum, though in the Paterson plant they do not seem to converge. I think we may say, then, that the New South Wales *P. intricatum* differs from the type in the following respects: (1) Inflorescence more spike-like, (2) flowers smaller and darker in colour, (3) sepals and petals gland-tipped.

3. Pterostylis ophioglossa R.Br., var. collina, n. var. Text-fig. 2.

I have called attention (*Aust. Nat.*, Feb., 1927) to a red-flowering hill form of this orchid, occurring high up in gullies along the flanks of the Paterson Valley. Continued observations of this form seem to me to justify fully the bestowal of varietal rank. As compared with the type-form, it may be described as follows: Stem relatively taller, flower smaller. Upper portion of the flower, and principal bands and veins, rich red-brown. Galea very shortly acute. Lateral sepals only shortly prolonged. Labellum usually more recurved, and always very dark in colour. Hybridization is immediately suggested as the possible explanation of these differences, but I am unable to add the probable name of the second parent. *P. pedunculata* might account for the dimensions and colour, but it is not easy to imagine how this species and *P. ophioglossa* could be contemporary; or why, in that case, the hybrid should be entirely restricted to the higher levels.

A REVISION OF THE AUSTRALIAN BOMBYLIIDAE (DIPTERA). III.

By Frederick H. S. Roberts, M.Sc.

[Read 27th November, 1929.]

Subfamily Systropinae.

Head about as broad as the thorax; occiput never raised, bilobate above or with a central cavity; eyes with the hind borders entire, contiguous in both sexes (*Systropus*), or separated in the female only (*Dolichomyia*). Antennae approximate at the base, rather long in *Systropus*. Proboscis slender and porrect, at least as long as the head; palpi slender, consisting of one segment. Thorax greatly arched with a conspicuous development of the metasternum; bristles almost absent; scutellum small, semicircular in shape. Abdomen elongate and usually pedunculate. Legs with the hind pair greatly elongated, the hind femora and sometimes the tibiae swollen apically. Wings short and narrow, devoid of an alula and with a greatly reduced lobe; M with two branches only; cell Cu closed.

This subfamily is represented in Australia by two genera, *Systropus* and *Dolichomyia*. Nothing is known in this country of the life histories of any of the species, but in Africa and America species of *Systropus* have been bred from moths of the Limacodidae and Notodontidae.

Key to the Genera of the Systropinae.

1. Large flies with the eyes in both sexes contiguous; abdomen swollen apically and decumbent in both sexes ..... *Systropus* Wied.
   Small flies with the eyes contiguous in the males only; abdomen in the males but slightly swollen apically, the apex upraised, in the females usually broadest medially and decumbent ..... *Dolichomyia* Wied.

Genus Systropus Wiedemann.

Nov. Dipt. Gen., 1820, 18; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 61.

Genotype, *S. macilentus* Wied. (Sth. Africa).

Head as broad as or broader than the thorax; occiput concave, bare; ocellar tubercle rounded, prominent, and placed at the head vertex; eyes closely contiguous in both sexes, reaching from the top to the bottom of the head, the facets small and of uniform size; frons small, reduced by the contiguous eyes, bare; face small between oral margin and antennae, extending as a thin strip to the cheeks. Antennae porrect, longer than the head, the first segment long and cylindrical, the second not quite half the length of the first, also cylindrical in shape, the third flattened, pointed, and about half as long as the first. Proboscis very long and thin, porrect; palpi slender, short.

Thorax strongly arched, sculptured, with a little thin pubescence and no spines; metasternum much developed; scutellum small, raised, devoid of spines. Abdomen very long and pedunculate, consisting of eight visible segments, the apical segments clubbed in both sexes; genitalia small; clothed with sparse hairs.

Fore and middle legs comparatively short and thin; hind legs very long and strong, stretching well beyond the tip of the abdomen, the femora somewhat clubbed at the apices, and with the tibiae, provided with a few short spines; pulvilli present but weak.

Wing, typical of the subfamily, i.e., the lobe is much reduced, the alula is missing, and M has only two branches; cell Cu closed.

Range.—Africa, Asia, North and South America, and Australia.

The genus contains but two species in Australia, both described as new and confined to Queensland, extending from Brisbane to Cairns.

Key to the Species of Systropus.

1. Black and yellow species with the apex of the abdomen black .... *flavo-ornatus,* n. sp.
   Black and brown species with the abdomen uniformly brown ..... *doddi,* n. sp.

SYSTROPUS FLAVO-ORNATUS, n. sp.

♂. Head silver-grey; eyes approximate near the ocellar tubercle, contiguous for a short distance near the antennal triangle; frons dark, with a median vertical groove extending from near the base of the antennae to meet a deeper transverse groove at its middle; face small, yellowish, silver-grey from above, extending as a thin strip to the cheeks. Antennae about twice the head length, the first segment yellowish with the apex black, second and third segments black, the first two segments with short black hairs, the third with minute hairs of the same colour. Proboscis black, about twice the head length; palpi short, brownish, about one-fourth the length of the proboscis.

Thorax rugosely punctate, deep black, with yellow lateral margins, the black gradually broadening from the scutellum to the head to form two large rounded shoulders, from thence continuing to head as a much narrower neck; the yellow margins are interrupted on each side by a black band reaching to the wing insertions; propleurae yellow, meso-, ptero-, and sternopleurae black, hypopleurae black, stained yellow adjacent to the coxae; metasternum yellow, greatly developed; scutellum black, with a rounded, median, yellow area; halteres elongate, brownish with yellow knobs.

Abdomen much compressed apically, with the apical club well developed; first segment yellow with a broad, black band, which appears continued dorsally as a faint stripe; apical segments black, remaining segments yellow; ventrally and laterally there are two narrow black stripes, interrupted at the borders of each segment; genitalia apparent as one or two small black spines.

Fore legs uniformly yellow with the apical tarsi brown; middle legs with the coxae black, the femora yellow, sometimes with the basal two-thirds blackish; the tibiae yellow, with short black spines, and the basal tarsi yellow; hind legs with the coxae black, the clubbed apices of the elongate femora black, otherwise the femora are yellow, tibiae yellow with the median third black; tarsi black, the whole with numerous, short, black spines; pulvilli brownish.

Wings greyish hyaline, lightly fuscous at the base and along the fore border. Holotype ♂, Westwood, Central Queensland, February, 1927, A. P. Dodd, allotype ♀, Westwood, A. N. Burns, 15th January, 1925. Length of body: ♂, 24 mm., ♀, 22 mm.; of wing: ♂, 12 mm., ♀, 11 mm.

The female is similar to the male and can be distinguished only by the genitalia which are usually exserted.

There are eight paratypes (4 ♂, 4 ♀), collected by Mr. A. P. Dodd on a small flowering shrub at Westwood in February, 1927.

The holotype and allotype are in the Queensland Museum.

SYSTROPUS DODDI, n. sp.

♀. Head grey; eyes contiguous for a short distance below the black ocellar tubercle; frons dark grey, with a median vertical and a transverse groove as in *flavo-ornatus*; face small, greyish, extending as a thin strip to the cheeks. Antennae about twice the head length, the first segment black, yellow at base, the second and third black, all with short black hairs, those on the third segment being very minute. Proboscis black, long and slender; palpi small, yellow.

Thorax as in *flavo-ornatus* except that the yellow colour is replaced by brown; halteres with brownish knobs. Abdomen much compressed apically, the apical club well developed; the basal segments yellowish turning to brown apically; basal segment with a black band which is continued dorsally as a dark, indistinct stripe; ventrally and laterally there are two narrow black stripes, interrupted at the hind border of each segment. Fore legs yellow with the apical tarsi brown; middle legs with the coxae blackish, the femora and tibiae yellowish-brown; hind legs with the femora brownish, the apical third yellow, the tibiae and tarsi black; pulvilli brownish.

Wings greyish, the base and fore margin lightly fuscous.

Holotype ♀, Stradbroke Island, Queensland, H. Hacker, 5th December, 1913. Length of body, 25 mm.; of wing, 12 mm.

The male is unknown. Four paratype females are before me, 2 ♀, F. P. Dodd, Kuranda, North Queensland, March, 1927; 1 ♀, A. P. Dodd, Cairns, and 1 ♀ unlabelled.

The holotype is in the Queensland Museum.

Genus DOLICHOMYIA Wiedemann.

Aussereurop. zweifl. Ins., ii, 1830, 642; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 61.

Genotype, *Dolichomyia nigra* Wiedemann.

Head somewhat globular, about as broad as the thorax; occiput concave above, convex below; eyes large, contiguous in male, separated in the female; frontal triangle small; face small, extending as a thin strip to the cheeks; ocellar tubercle large, rounded and prominent. Antennae not as long as head, the first segment cylindrical, the second about half the length of the first, the third about as long as the first, compressed and apically pointed. Proboscis at least as long as the head, porrect and somewhat slender; palpi slender, usually rather long.

Thorax much arched, of great depth, clothed with sparse hairs; scutellum small, semicircular in shape; squamae minute; halteres elongate, with much enlarged knobs. Abdomen long and slender, the apex upraised in the male and slightly clubbed; in the female, it is laterally compressed, decumbent and usually broadest medianly; genitalia complex. Fore and middle legs short, hind legs very long and strong, apices of femora clubbed and usually armed ventrally with two rows of short, strong spines; tibiae also sometimes with apices clubbed; pulvilli weak.

Wings short and narrow, typical of the subfamily; the costa is continued right round the wing; Sc and R_1 are contiguous for a distance, so that the cell Sc is much reduced; R_{2+3} at most but little curved; M with only two branches; mc somewhat acute at base; 1A is straight and meets Cu_1 at the wing margin.

Range.—Europe, North America, and Australia.

Three species are known, two of which are regarded as new. Hardy's *clavifemoratus* is known from both New South Wales and Queensland, *occidentis* from Western Australia and Queensland, whilst *minima* appears to be confined to the latter State.

Key to the Species of Dolichomyia.

1. Very small species with the cubital fork of the wing rather broad, i.e., R_4 is straight and meets the margin well distant from R_5 2
   Larger species with the cubital fork narrow, i.e., R_4 is curved and meets the margin not so distant from R_5 ..... *clavifemoratus* Hardy.
2. Humeral angles yellow, abdomen with brownish lateral markings; tibiae with apical half little swollen ..... *minima*, n. sp.
   Humeral angles black, abdomen with grey lateral markings; tibiae with apical half greatly swollen ..... *occidentis*, n. sp.

DOLICHOMYIA CLAVIFEMORATUS Hardy.

Systropus clavifemoratus, Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 61, pl. xvii, figs. 16, 17, 18 and 19.

♂. Head dark grey; occiput grey, clothed with sparse white tomentum and bearing a row of minute bristles; eyes approximate near the black ocellar tubercle, contiguous near the antennal triangle. Antennae short, about half the length of the head, black, typical of the genus. Proboscis black, about as long as the head, porrect; palpi dark, reaching to the upturned portion of the proboscis. Face between antennae and oral margin small, extending as a thin strip to the cheeks

Thorax dark grey, with two indistinct black, admedian stripes and a black lateral ridge; pleurae grey separated from the grey of the thorax by a narrow black stripe, the whole clothed with very sparse white pubescence more apparent on the mesonotum; scutellum black; halteres brownish. Abdomen black with grey lateral markings and a grey venter; each segment is narrowly bordered posteriorly by yellow. Fore and middle legs brownish-yellow, with grey coxae and stained fuscous at the base and on the tarsi; hind legs with the coxae grey, the hind femora black, with usually the apical third swollen, with a ventral yellowish mark at the base of this swollen part, and provided with two rows of about ten short, black spines; tibiae yellow with the base and apex broadly black; tarsi black; pulvilli yellowish.

Wings hyaline and glistening; R_4 curved.

The female is similar except for the abdomen and the separated eyes.

Hab.—Queensland: Brisbane (September), Chinchilla (October), Westwood (February); New South Wales: Blackheath (November), Kosciusko (February).

Of the twelve specimens under examination, six agree with Hardy's description, except that the segments of the abdomen possess a narrow yellow hind border. The absence of this character in the type was possibly due to the telescoping of the segments. In the other six the clubbed portion of the hind femora varies to one-half the length, becoming somewhat broader. In three of these specimens the markings of the abdomen tend to a brown colour. It is possible that more than one species is represented by this series, but at the present time I am unable to detect any definite characters for their separation, and have had to be content with regarding *clavifemoratus* as being somewhat variable.

DOLICHOMYIA MINIMA, n. sp.

♂. Head grey; occiput grey with sparse whitish pubescence; eyes approximate near the ocellar tubercle, contiguous near the antennal triangle. Antennae about one-half the length of the head, the first two segments greyish, the third black, typical of the genus. Proboscis black, about as long as the head; palpi slender, reaching almost to the upturned portion of the proboscis; face and frons small, the face extending as a thin strip to the cheeks.

Thorax dark grey or blackish, the humeral angles yellow, clothed with short, sparse, pale hairs; pleurae grey, also with sparse pale hairs; scutellum black; halteres brownish with yellow knobs. Abdomen elongate and slender, the apex upraised and slightly clubbed; shining black, with brownish lateral markings and venter. Fore and middle legs yellowish, the coxae of the fore legs dark, and the apical tarsi of both, brown; hind legs with the coxae dark, the femora with the broadly clubbed apical third black, otherwise yellow with a fuscous streak extending dorsally from the base to the black club; a double row of about twelve short, strong, black spines beneath; tibiae slightly clubbed apically, yellow with the apical third black; tarsi black; all pulvilli yellow.

Wings hyaline; R_4 not curved and meeting the wing margin some distance from R_5; cell mc rather acute at base.

The female, except for the separated eyes and the differently shaped abdomen, agrees with the above description in every respect.

Holotype ♂, Chinchilla, Queensland, October, 1926, B. Smith; allotype ♀, Waroo, Southern Queensland, February, 1928, G. H. Hardy. Length of body: ♂, 5 mm., ♀, 6 mm.; of wing: ♂, 3·5 mm., ♀, 4 mm. Paratypes: 1 ♂, Gravesend, N.S.W., 10th January, 1929, A. P. Dodd; 2 ♀, Brisbane, 10th March, 1918, H. Hacker; 4 ♂, 1 ♀, Waroo, February, 1928, G. H. Hardy.

The holotype and allotype are in the Queensland Museum.

DOLICHOMYIA OCCIDENTIS, n. sp.

♂. Head grey; occiput silver-grey, covered with sparse, rather long, white hairs, which extend to the chin to form a thin beard; eyes contiguous for a distance below the ocellar triangle; ocellar tubercle black, with a few pale hairs. Antennae with the first two segments grey, the third black, typical of the genus. Proboscis slender and black, longer than the head; palpi slender, reaching to the upturned portion of the proboscis. Face and frons small, the former extending as a thin strip to the cheeks.

Thorax dark grey, silver-grey laterally, with two short, admedian black stripes and a narrow black lateral ridge, covered with short and sparse white hairs; pleurae grey with scattered white hairs, more apparent on the mesopleurae; scutellum shining black; halteres pale with yellow knobs. Abdomen black, long and slender with the apex upraised and little clubbed, the segments with rather large and distinct grey lateral markings and narrow posterior yellow borders; venter grey; the pubescence consists of scattered white hairs, more concentrated basally and laterally to form two tufts. Legs with the coxae grey, the fore and middle legs yellowish, the femora at the base and all tarsi, brown; hind legs with the apical third of the femora clubbed and black, the rest of the femora being yellow, black basally and with a brownish streak above; spines apparently wanting; tibiae with the apical half swollen as much as, if not more than, that of the femora, yellowish, the swollen half black; tarsi black; pulvilli yellow.

Wings hyaline; R_4 not curved; cell mc acute at base.

The female is similar in every way to the male, except for the separated eyes and the differently shaped abdomen.

Holotype ♂, Kojarena, Western Australia, 6th September, 1926, A. J. Nicholson; allotype ♀, similar data. Length of body: ♂, 8 mm., ♀, 9 mm.; of wing: ♂, 4·5 mm., ♀, 5 mm. Paratypes: 12 ♂ (same data); 1 ♀, Kojarena, 6th September, 1926, E. W. Ferguson.

Included in the series of this species are eight specimens from Brisbane. All of these agree with the above description, except that in each the hind femora bear two rows of short strong spines below. Not one of the Western Australian specimens gave any evidence of this character, though each was submitted to a very close examination. The species may readily be recognized by the greatly swollen femora and tibiae in conjunction with the clear grey markings of the abdomen.

The holotype and allotype are in the Macleay Museum.

Subfamily Toxophorinae.

Eyes large, their hind borders not indented and devoid of a bisecting line; occiput flattened, without any bilobation or central cavity. Proboscis porrect, extending beyond the head; palpi slender and consisting of one segment. Prothorax much developed and beset with numerous strong bristles.

This subfamily in Australia is represented by the one genus, *Toxophora*.

Genus Toxophora Meigen.

Illig. Mag. Insect., ii, 1803, 270.

Genotype, *Asilus maculatus* Rossi. (Europe), by Meigen's designation.

Head about as broad as thorax; eyes large, contiguous in male, separated in the female; ocellar tubercle prominent and placed at the head vertex. Antennae porrect, much longer than the head, approximate at the base, the first segment long and slender, cylindrical, the second about half the length of the first, the third apically pointed, not quite as long as the second, and usually provided with a small terminal style. Proboscis about as long as the head, sometimes longer, curved up towards the antennae; palpi long and slender. Frons much reduced in the male by the contiguous eyes; face rather broad.

Thorax strongly arched with a great development of the prothorax, which is provided with strong, curved bristles, the whole clothed with scales; other thoracic macrochaetae well developed; scutellum semicircular in shape, with a few long marginal bristles; halteres slender. Abdomen somewhat cylindrical and decumbent, clothed with scales and a few sparse hairs. Legs of about equal length, with the femora rather long and strong; fore and middle legs with few spines, those on the hind legs numerous and well developed; pulvilli present.

Wings rather narrow, with the lobe somewhat reduced; M with only two branches; cell mc sharply acute at the base; cell R_3 with an interradial vein; vein Cu_1 curved to meet the vein A_1 before the wing margin.

Range.—South Europe, Asia, North and South America, and Australia.

This genus, which is recorded from Australia for the first time, is represented by one species, *compta*, which is new. Nothing is known of the life history or habits of these peculiar Bombyliidae. They are supposedly parasitic on Hymenoptera. The three specimens representing the species were captured on flowering shrubs.

Toxophora compta, n. sp.

♂. Head black; occiput black, bearing stiff yellowish hairs; ocellar tubercle black, rounded; eyes approximate near the ocellar tubercle, contiguous to near the antennal triangle; frons much reduced by the contiguous eyes, covered with black scales, yellow haired near the base of antennae; face black, with black scales and a few black hairs, the upper portion of the cheeks with depressed, bright yellow hairs. Antennae black, the first segment yellowish basally, with numerous short black hairs; style small. Proboscis somewhat longer than the head, black, with enlarged black labella; palpi slender, black, about half the length of the proboscis.

Thorax black, covered with dorsal brown and black scales and thin whitish pile, with two bright yellow patches of tomentum on each side of the prothorax; bristles very long and strong, those on the prothorax curved backwards, black; scutellum black, with dorsal black and marginal yellow scales; bristles thin, black; pleurae grey-black with sparse pale pubescence, the mesopleural tuft pale yellow; halteres brownish, knobs yellow; squamae whitish with a fringe of white cilia. Abdomen about as long as head and thorax together, not much narrower at the apex than at the base, covered with black scales, with two yellow bands, the basal band interrupted medianly, and with short yellow hairs at the apex. Legs with the coxae blackish, the fore and middle femora black with the apical third brown; hind femora brown; all tibiae brown, the tarsi darker; the whole with black and brown scales; spines black; pulvilli brownish.

Wings blackish at the base and along the fore margin to the apex and for two-thirds the depth, clearing to the inner margin; costal border brownish.

Holotype ♂, Brisbane, 6th March, 1918, H. Hacker. Length of body, 9 mm.; of wing, 7 mm. The female is unknown. One paratype male exists, captured in Brisbane in October, 1926, by the author. There is another male in the Australian Museum labelled Gayndah, Q.

The holotype is in the Queensland Museum.

Subfamily Cylleniinae.

Head broad; occiput raised, bilobate above, with a central cavity, and with a fringe typically placed at the borders of this cavity; eyes devoid of an indentation of the hind borders and of a bisecting line. Antennae approximate at the base, porrect. Proboscis sometimes longer than the head, the palpi one- or two-segmented. Thorax usually flattened. Abdomen usually somewhat broad and flattened. Legs slender, sometimes with strong spines; pulvilli present. Wings strong; vein R_{2+3} sometimes looped and recurrent; M with three branches; cells R_3 and R_4 sometimes with interradials.

I have placed two genera here, *Neosardus* and *Myonema*, both of which are new. *Neosardus* is closely allied to the African genera, *Nomalonia* and *Henica*, but may be easily distinguished from either by the much smaller development of the bristles and by the different venation. *Myonema*, except for the absence of the hind indentation and bisecting line of the eyes, bears a close relationship to the subfamily Lomatiinae.

In a note on the subfamily key, given in Part 1 of this series, I placed *Marmasoma* and *Eclimus* in this subfamily, but remarked on the smaller development of the bilobation and central cavity of the occiput. Although both these genera were placed by Bezzi in the Cylleniinae, I have since decided, in order to avoid any confusion in following the key, to ally them with the subfamily Phthiriinae.

Key to the Genera of the Cylleniinae.

1. Cells R_3 and R_4 with interradial veins; antennae as long as head .. *Neosardus*, n. gen.
   Cells R_3 and R_4 without interradial veins; antennae very much shorter than the head ..... *Myonema*, n. gen.

Genus Neosardus, n. gen.

Genotype, *Neosardus principius*, n. sp.

Head broad and shining; occiput inflated, bilobate above and with a distinct central cavity; eyes small, not reaching to the bottom of the head, separated in both sexes; ocellar tubercle large, rounded, and placed at the vertex of the head. Antennae placed above the middle of the head, approximate at base, porrect and about as long as the head; first segment long and cylindrical, second short, about one-third the length of the first, third not as long as the first, somewhat conical in shape, with a blunt apex and provided with a distinct and terminal style. Frons raised, rather broad; face very broad, the cheeks separated from the small and raised oral opening by distinct grooves. Proboscis erect, as long as, or longer than, the head, rather stout; palpi elongate and slender, two-segmented, the second segment about one-third the length of the first.

Thorax somewhat quadrate in shape, rather flattened, clothed with shining scales and bearing thin pre- and post-alar bristles; scutellum semicircular in shape, cushion-like, the margin with thin long bristles; halteres slender; squamae small. Abdomen consisting of seven visible segments, somewhat flattened, as long as, or longer than, the head and thorax together, usually with a truncated tip, and clothed with shining scales and sparse hairs. Legs rather slender, the hind pair elongate; tibiae with rows of spines, more developed on the hind tibiae; middle and hind femora with few and many spines beneath; pulvilli small, weak.

Wings strong with well developed lobes and alulae; vein R_{2+3} looped, the loop being sometimes a little recurrent; cells R_3 and R_4 each with an interradial; cell mc sometimes angulated below, the angle sometimes marked with a short appendix; M with three branches; cells R_5 and Cu open; Cu_2 incomplete.

This genus has been erected to include four species, all new, which agree in every respect with the above characters. Its nearest allies are to be found in the African genera, *Nomalonia* and *Henica*, from both of which it may be readily distinguished by the antennae, the less bristly thorax and legs, and by the venation.

Distribution.—The records of the few specimens of the four species show that *nigratus* appears confined to Western Australia, *circumdatus* and *lepidus* to New South Wales and *principius* to Queensland and South Australia.

Key to the Species of Neosardus.

1. Vein R_{2+3} recurrent, the loop about as broad as deep, the wings with a broad, black, basal pattern ..... *nigratus*, n. sp.
   Vein R_{2+3} little recurrent, the loop longer than deep 2
2. Abdomen with yellow posterior borders to the segments; thorax with yellow humeral angles ..... *circumdatus*, n. sp.
   Abdomen at most with narrow brown posterior borders to the segments; thorax without yellow humeral angles 3
3. Small species, the wings with a definite brown pattern, the brown descending as a broad band across the wing, but not reaching the hind margin .. *principius*, n. sp.
   Larger species, the wings brownish, the apex broadly hyaline; no band present .... *lepidus*, n. sp.

NEOSARDUS CIRCUMDATUS, n. sp.

♀. Head shining yellow; occiput with a well marked bilobation and central cavity, covered with short, pale hairs; ocellar tubercle shining black; frons yellow with short yellow hairs; face yellow, the cheeks and chin grey, clothed with soft, short, white hairs. Antennae with the first segment yellow, with short yellow hairs, the second black, with black and some yellow hairs; third missing. Proboscis black, about as long as the head, the labella enlarged; palpi slender, yellow, about one-half the length of the proboscis.

Thorax black, grey laterally, with yellow humeral angles, with traces of greenish scales; pre- and post-alar bristles pale brownish; scutellum brownish-yellow with pale, brown, marginal bristles; pleurae and breast grey with sparse pale yellow and white hairs; halteres yellow. Abdomen shining black, the segments with prominent, yellow, posterior borders; tomentum apparently consisting of greenish scales, short, appressed, brownish hairs and a white basal tuft; venter mainly yellow, the segments with black anterior borders and covered with short, appressed yellow hairs. Legs with the coxae grey, the fore and middle legs light brown with darker apical tarsi; hind legs dark fuscous, the femora below, the apex of the tibiae and all tarsi black; coxae with white hairs, legs otherwise with yellowish scales and weak pale pulvilli.

Wings light fuscous at the base and along the costal border to the apex of R_1, leaving the lobe and apical half hyaline; R_{2+3} little recurrent, the loop being longer than deep; cell M with a hyaline spot.

Holotype ♀, Broken Hill, N.S.W., C. Deane; no date. Length of body, 10·5 mm.; of wing, 9 mm. Paratype ♀, data similar.

The specimens are rather rubbed, but the colours are outstanding enough to determine the species.

The holotype is in the Queensland Museum.

NEOSARDUS LEPIDUS, n. sp.

♀. Head a shining yellowish-brown; occiput paler below, with a distinct bilobation and central cavity, covered with short pale hairs; ocellar tubercle black, shining; frons shining yellow with black hairs; face yellow between oral margin and antennae, pale on the cheeks, clothed with short pale hairs which are continued to the chin to form a short sparse beard. Eyes typical. Antennae with the first two segments yellowish with short black hairs, the third black with a small but distinct style placed on one side of the broad apex. Proboscis black, as long as the head; palpi slender, yellow, about half the length of the proboscis.

Thorax black, covered with beautiful, green, reflective scales and bearing pale brown pre- and post-alar bristles; scutellum shining brown, black basally, clothed with similar scales, the marginal bristles thin and brown; hairs clothing the thorax sparse and brown; pleurae grey with sparse white hairs, the mesopleural tuft longer and denser; halteres pale brownish, the knobs partly black. Abdomen shining black, brownish on the sides, the apical segments with narrow brown posterior borders, the whole covered with scales, similar to those of the thorax, and with short, depressed, dark hairs; basal tuft white, the hairs being continued on each side of the scutellum, but short and equal; laterally for about half the length the hairs are thin and white; venter greyish with short brownish hairs. Legs with grey coxae, the fore and middle legs brown with black apical tarsi;

hind legs dark brown; coxae with white hairs, tomentum of legs otherwise consisting of pale scales; pulvilli pale; spines short and black.

Wings with the basal half brownish, the apical half hyaline; loop of R_{2+3} a little recurrent; venation typical.

Holotype ♀, Gravesend, N.S.W., January 1st, 1929, H. Nicholas. Length of body, 10·5 mm.; of wing, 8 mm. Paratypes: 2 ♀, Gravesend, December, 1928, H. Nicholas.

The holotype is in the Macleay Museum.

NEOSARDUS PRINCIPIUS, n. sp.

♂. Head grey; occiput with a distinct bilobation and central cavity, with some erect black hairs above and white hairs below, the latter extending to the chin to form a sparse beard; ocellar tubercle shining black. Eyes separated at the vertex by about one and one-half times the width of the ocellar tubercle. Antennae typical, the first and second segments with some short black hairs, the third rather stout; style distinct. Proboscis black, as long as the head; palpi pale yellowish with a few pale hairs. Frons grey, brown from above, covered with erect black hairs; face very broad, grey, but brown between antennae and oral margin, the mouth borders brownish; brown area with short black hairs, the face otherwise covered with sparse white hairs, longer on the chin.

Thorax brownish, grey anteriorly and laterally, clothed in front and on the sides with sparse white pubescence, the dorsum with beautiful, reflective, coppery and green scales; pre- and post-alar bristles thin, brownish; scutellum black covered with similar scales and bearing long, thin, pale, marginal bristles; pleurae and breast grey, with sparse white hairs, more apparent on the mesopleurae; halteres yellowish beneath, brown above. Abdomen black, about as long as the head and thorax together, covered with scales similar to those on the thorax, and bearing short equal white hairs laterally, longer and denser basally from where they reach across the dorsum to form a thin basal band. Legs with the coxae grey; fore legs brownish, the basal half of the femora and the apical tarsi, black; middle legs mainly brown, tarsi darker; hind legs with the tibiae brown, femora and tarsi mainly blackish; tomentum consisting of white hairs on the coxae and pale scales on the femora and tibiae; pulvilli pale.

Wings hyaline, with an irregular brown pattern which is continued along the costal border to a little beyond the apex of R_1 and reaching across the wing as a broad band to colour all cell mc, the basal portion of cell M_4, and the adjacent part of the broadly open cell Cu. The outline is rather irregular, leaving a large hyaline patch in cell 1st R_3, and colouring one-third of cell R_5, and the basal third of cell M_2; there is a large hyaline area in cell M; curve of R_{2+3} little recurrent; R_5 broadly open; venation typical.

Holotype ♂, Emerald, Q., November 18th, 1928, F. Roberts; allotype ♀, Chinchilla, Q., November 20th, A. P. Dodd. Length of body: ♂, 7 mm., ♀, 8 mm.; of wing: ♂, 5 mm., ♀, 5·5 mm. The female is similar to the male except for the widely separated eyes. Paratypes: 2 ♂, Chinchilla, November 14th, 1927, B. Smith; 1 ♂, Goondiwindi, Q., December 30th, 1927, F. Roberts; 1 ♂, Chinchilla, as in allotype; 2 ♂, Brisbane, November 28th, 1917, H. Hacker.

There are twelve additional specimens in the Macleay Museum from South Australia.

The holotype and allotype are in the Queensland Museum.

NEOSARDUS NIGRATUS, n. sp.

♂. Head metallic brown; occiput with a distinct bilobation and central cavity, covered with short pale hairs, with some brown scales near the bilobation; ocellar tubercle large and shining black, with some erect, pale yellowish hairs. Eyes small, separated at the vertex by about one and one-half times the width of the ocellar tubercle. Frons shining brown, broad, covered with erect and equal black hairs; face very broad, at its narrowest point about twice the width of an eye, clothed with short, equal, and erect white hairs, which form a somewhat short and sparse beard on the chin, and a few erect black hairs between the oral margin and antennae. Antennae about as long as the head; black, the first segment brownish, the first two segments with short black hairs, the third somewhat elongate-conical in shape and provided with a stout terminal style. Proboscis black, about three times the head length; palpi pale brown, about one-third the length of the proboscis and bearing short sparse hairs.

Thorax black, covered with shining and reflective coppery scales and sparse, erect, black hairs; collar consisting mainly of whitish hairs, denser below; bristles thin and brown; pleurae shining brown, the mesopleural tuft dense, pale brown above, white beneath; halteres pale brown with pale yellowish knobs; scutellum brown, black basally, with tomentum similar to that of the thorax, the margin with thin, brown bristles. Abdomen stout, curved, broader than the thorax, shining black, with a short white basal band, which extends laterally as two white tufts, sparse, erect black hairs, which are densest laterally, and scales similar to those of the thorax. Legs with the coxae and femora blackish, bearing sparse, black and pale hairs; tibiae brown; tarsi black, pulvilli pale.

Wings with the basal half dark brown, the apical half hyaline, the colour extending across the wing to where M_{3+4} meets the margin and containing two small hyaline spots; R_{2+3} much looped apically, the loop being about as broad as its depth, the vein recurrent; cell mc angulated below, the angle frequently marked by a small appendix; R_5 narrowly open; r-m placed a little before the middle of mc.

Holotype ♂, Armadale, Western Australia, J. Clark; allotype ♀, data similar. Length of body: ♂, 11 mm., ♀, 10 mm.; of wing: ♂, 10 mm., ♀, 8·5 mm. The female has the eyes more broadly separated and the brown of the wings much lighter, but is otherwise similar to the male. Paratypes: 1 ♂, 2 ♀, also from Armadale and captured by J. Clark.

The holotype and allotype are in the Macleay Museum.

Genus MYONEMA, n. gen.

Genotype, *Myonema humilis*, n. sp.

Head rounded, about as broad as the thorax; occiput raised, bilobate above, with a large central cavity and with a short fringe at the border of this cavity. Eyes reaching the full height of the head, separated in the male at the head vertex by about half the width of the ocellar tubercle, the hind borders with a well marked concavity; ocellar tubercle large, rounded, placed well below the head vertex, the ocelli large. Face very small between upper mouth borders and antennae, narrowing a little towards the chin. Antennae small, the first segment broad and somewhat cupuliform, the second very small and globular, the third as long as the first and second together, somewhat spindle-shaped viewed from the side, but when viewed from above the inner surface is concave; style

spine-like, apical. Proboscis short and rather stout, hardly longer than the oral opening, the labella enlarged; palpi slender, curled, about half as long as the proboscis.

Thorax longer than broad, almost flattened, covered with erect and appressed pile, the pre-alar bristles evident, but weak; scutellum broad and semicircular in shape; the mesopleural tuft long and dense; halteres rather small and slender; squamae small with a long fringe. Abdomen consisting of seven segments, the eighth with the genitalia, rather narrow, but broadening to the fifth segment, the apical segments decumbent. Legs slender, the femora rather stout; tibiae with spicules, more developed on the hind tibiae; pulvilli present.

Wings rather narrow, the lobe reduced and the alula wanting; R_{2+3} but little curved at the apex; cells R_3 and R_4 undivided; cells R_5 and Cu open; M with three branches; cell mc about twice as long as broad, the cross-vein r-m placed a little before its middle.

This genus is represented by the one species, all the specimens of which were taken at Brisbane, Queensland. The genus, especially in the shape of the head, with its raised and bilobate occiput and large central cavity, and antennae, bears an affinity to the Lomatiinae. The absence of the hind indentation and bisecting line of the eyes makes it at once distinct, although the hind margins are conspicuously concave.

MYONEMA HUMILIS, n. sp.

♂. Head greyish; occiput covered with appressed white pile, the fringe at the borders of the central cavity short and white; ocellar tubercle large and black, crowned with erect, black hairs. Eyes separated at the head vertex by about one-half the width of the ocellar tubercle; head between ocellar tubercle and vertex velvety black, with some black hairs. Frons black, grey towards antennae, with black and white hairs, the latter on the grey area; face little projecting between the eyes, covered with dense whitish or pale brownish pile; chin with a soft, white beard. Proboscis black; palpi with the basal two-thirds black, the apical third brown, with sparse pale hairs, longest basally. Antennae with the first two segments with long white hairs below and with intermixed black, laterally.

Thorax black, the prescutellar suture greyish, covered in front and on the sides with erect whitish pile and dorsally with appressed white tomentum and erect black and white hairs intermixed; bristles brown; mesopleural tuft somewhat yellowish below; breast brown haired; halteres with black knobs; squamae with a long, dense, white fringe. Abdomen black, the three basal segments and the apical segments with appressed white pile; segments four and five with appressed brown pile; laterally, as far as segment three, the hairs are clear white, from thence to the apex the white hairs are replaced by black tufts; genitalia exserted. Legs brown, the coxae and tarsi blackish; coxae and femora with long pale hairs, which on the middle and more so on the hind femora become very dense and black on the apical third; pulvilli pale.

Wings hyaline, dark brown at the base and along the fore margin to near the apex of the vein R_{2+3}, the inner border of the colour extends from the base along the lower vein of cell M, thence towards the apex with two conspicuous waves; cell M with a small hyaline area.

Holotype ♂, Brisbane, Q., August 20th, 1918, H. Hacker. Length of body, 10 mm.; of wing, 9 mm. Paratypes: 1 ♂, Brisbane, September 12th, 1927, J.

Mann; 1 ♂, Brisbane, September, G. H. Hardy; 6 ♂, Brisbane, August, 1918, H. Hacker.

The genotype is in the Queensland Museum.

Subfamily Cyrtosiinae.

Eyes with the hind borders entire and without a bisecting line; occiput not inflated, devoid of a bilobation above and a central cavity. Wings with R_4 always missing; R_{2+3} sometimes missing or, when present, sometimes meeting the vein R_1 well before the wing margin to form an extra subtriangular cell; cell mc complete, or confluent with cell M, or entirely wanting; M with three branches.

This subfamily comprises very few species, all of which are peculiar for their extremely small size and reduced venation. At various times they have been placed by Dipterists in the families Cyrtidae and Empididae and it is only comparatively recently that their position in the Bombyliidae has been assured. They are apparently captured only around flowers, though *Cyrtomorpha paganica* is met with on sand dunes. The species of *Pachyneres* are aberrant among Bombyliids for, whereas all the life histories known show that the larvae are either parasitic or predaceous, *Pachyneres* has been recorded in America as being bred from decaying vegetation. It is highly probable, however, that these Bombyliids are parasitic or predaceous on other insects which breed therein.

Of the six genera which comprise the subfamily, three are represented in the Australian region, viz., *Pachyneres*, *Cyrtosia* and *Cyrtomorpha*, *Cyrtosia* being recorded for the first time. A controversy has recently arisen as to whether Malloch's *P. australis* is indeed a Bombyliid. There seems to be no doubt but that it is, its affinities with the genus *Glabellula* being such that it is only distinguished by the short and broad third antennal segment. *Cyrtosia* bears a great resemblance to *Cyrtomorpha*, the only difference being in the relative lengths of the respective proboscides. White considered that in *Cyrtomorpha* the vein R_{2+3} was shorter than in *Cyrtosia*, and that whilst in *Cyrtosia* the cell R was but little longer than the cell M, in his genus it was much longer. This is true of *Cyrtomorpha paganica*, but in the other species, *flaviscutellaris*, the vein R_{2+3} is rather long and the cell R is not much longer than the cell M.

Key to the Genera of the Cyrtosiinae.

1. Proboscis much longer than the head ..... *Cyrtosia* Perris
   Proboscis not longer than the head 2
2. Cells mc and M confluent; vein R_{2+3} meeting the vein R_1 well before the wing margin to form an extra subtriangular cell; third antennal segment short and broad ..... *Pachyneres* Greene
   Cell mc wanting, the cell M complete; vein R_{2+3} meeting the wing margin; third antennal segment elongate ..... *Cyrtomorpha* White

Genus Cyrtomorpha White.

Proc. Roy. Soc. Tasm., 1916, 185; Hardy, *ibid.*, 1921, 64.

Genotype, *Cyrtomorpha paganica* White.

Head small, set low down on the thorax; occiput flattened above, little inflated below; ocellar tubercle prominent and placed at the head vertex. Eyes separated in both sexes, but much more so in the female. Frons narrow and elongate in the male; face between upper mouth borders and antennae long and narrow, cheeks much reduced. Antennae not as long as the head, the first segment microscopic,

the second prominent and somewhat cylindrical, the third bulb-shaped, tapering towards the apex and provided with a long slender style of about its own length; proboscis short, not as long as head; palpi very small, one-segmented.

Thorax convex, covered with short, dense, erect hairs; squamae very small and bare. Abdomen short and broad, covered with short, equal and erect hairs. Legs slender, without bristles; pulvilli present. Wings with the cell mc missing and the cell M complete; R_{2+3} meeting the costa; R_5 meets the margin near the wing apex; cell Cu open.

Range.—Australia.

This genus contains two species, one of which is regarded as new. White's species appears confined to Tasmania, whilst *flaviscutellaris* comes from Western Australia.

Key to the Species of Cyrtomorpha.

1. Scutellum black; R_{2+3} short ..... *paganica* White.
   Scutellum yellow; R_{2+3} long ..... *flaviscutellaris*, n. sp.

CYRTOMORPHA FLAVISCUTELLARIS, n. sp.

♀. Head black; occiput flattened, covered with sparse, erect, black hairs; eyes widely separated; ocellar tubercle black, crowned with erect black hairs; frons broad, concave and black, yellow on each side and close to the antennae, bearing a few black hairs; antennae black, the first and second segments with some short, yellowish hairs.

Thorax black with yellow humeral angles, brownish anteriorly, posteriorly and laterally, the black area reaching forward as a short neck; the black area with numerous short, erect, black hairs, the brown area with similar yellow hairs; pleurae yellowish with sparse yellow hairs; scutellum yellow with sparse yellow hairs; halteres yellow. Abdomen broad and rounded, yellow, the basal segment and the main portion of the second segment black, the whole with numerous short, erect, black hairs. Legs brownish-yellow, covered with pale hairs. Wings hyaline, the inner margin fringed with short cilia; R_5 meets the margin beyond the apex; R_{2+3} long and almost straight; cell R a little longer than cell M.

Holotype ♀, Swan River, W. Aust., L. J. Newman, November. Length of body, 5 mm.; of wing, 4 mm. Paratype: 1 ♀, also from the Swan River. In the paratype on both wings M_1 is incomplete, not reaching the wing margin.

The holotype is in the Macleay Museum.

CYRTOMORPHA PAGANICA White.

White, *Proc. Roy. Soc. Tasm.*, 1916, 186; Hardy, *ibid.*, 1921, 65.

♂. Head with the frons brownish-black, the face yellowish; occiput grey, covered with short, thin, pale pile; face with sparse yellow hairs; beard short, whitish; ocellar tubercle black. Antennae black, the first two segments with short black hairs. Proboscis black and slender, not as long as the head; palpi hidden.

Thorax black, the humeral angles yellow, somewhat brownish laterally and covered with dense, fine, equal and erect, pale yellow hairs; scutellum black, with similar pubescence; pleurae mainly blackish, almost bare; halteres with large yellow knobs; squamae small, pale brownish. Abdomen black, the hind margins of the segments yellow, the yellow bands increasing in size apically, so that the apical segments are mainly yellow, the whole covered with short, yellowish

pile, longest on the sides; venter yellowish with similar tomentum. Legs mainly yellow, the coxae and apical tarsi blackish, the femora brownish at the base and for about one-half their length below; tomentum consisting of pale hairs, longer on the femora; pulvilli pale.

Wings completely hyaline, the veins yellowish; venation normal; cell R longer than cell M; R_{2+3} short. Length of body, 4·2–4·5 mm.; of wing, 3·8–4·2 mm.

Hab.—Tasmania: Hobart (January).

Only three specimens of this species are known, all males, taken at Bellerive, near Hobart, on the 25th January, 1918. They are in the collection of Mr. G. H. Hardy.

Genus Cyrtosia Perris.

Perris, *Ann. Soc. Ent. France*, viii (1 and 2), 1839, 54.

This genus appears identical with *Cyrtomorpha* except for the proboscis, which is longer than the head, slender, porrect, the labella not enlarged, so that it appears of the piercing type met with in the Empididae.

Range.—Africa and Australia.

Only one species is known, *parvissima*, which is very small and was taken, whilst sweeping long grass, at Gogango, Central Queensland.

Cyrtosia parvissima, n. sp.

♂. Head black; occiput flattened, with short black hairs; eyes separated, the frons long and narrow, and narrowing towards the face, shining black, with a distinct median groove and sparse black hairs; face between antennae and oral margin very long and narrow, possessing at about half its length a minute tubercle, which bears some short, appressed, yellow hairs. Proboscis black, very long and slender, much longer than the head; palpi black, minute, with a few short, black hairs; oral opening very small and rounded. Antennae black, the first segment very small, the second prominent, both with small, black hairs, the third bulb-shaped, the style slender, and about as long as the segment.

Thorax black, the humeral angles yellow, the same colour visible on the sides and behind, covered with short pale pile; scutellum black; pleurae blackish-grey, yellow anteriorly, almost bare; halteres yellow. Abdomen black, the apical segments with narrow silver posterior margins, covered with short, erect, black hairs, the silver bands with white hairs. Legs with the coxae and basal two-thirds of the femora black; otherwise yellow, covered with short pale hairs.

Wings hyaline; M with three branches; R_{2+3} rather long; cell R but little longer than cell M; R_5 meets the wing margin at the apex; cell Cu narrowly open.

Holotype ♂, Gogango, Queensland, 29th March, 1929, A. P. Dodd; allotype ♀, data similar. Length of body: ♂, 1·5 mm., ♀, 2 mm.; of wing: ♂, 1·5 mm., ♀, 1.8 mm.

♀. The female differs from the male in having more widely separated eyes, and the apical segments almost wholly silver, the silver margins of the segments broadening apically.

The holotype and allotype are in the Queensland Museum.

Genus Pachyneres Greene.

Greene, *Proc. Ent. Soc. Wash.*, 26, 1924, 62; Malloch, *Austr. Zool.*, iii, 1924; Hardy, *Ibid.*, iv, Pt. vi, 1927.

Genotype, *Pachyneres crassicornis* Greene.

Head set low down on and closely applied to the thorax; occiput flattened. Eyes separated in both sexes, the frons narrowing towards the antennae. Ocellar tubercle occupying the head vertex. Antennae short, the first segment small, the third short and broad, its length about one and one-half times its width, and in the genotype provided with a terminal and thimble-like style. Proboscis short, not as long as the head; palpi minute.

Thorax convex, covered with hairs only; halteres slender; squamae minute. Abdomen short, clothed with hairs only. Legs slender and without bristles; pulvilli present.

Wings short and stout, the lobe well developed and the alula almost wanting; R_{2+3} present as a very short vein, upturned to meet the vein R_1 well before the costa, to form an extra subtriangular cell; cells M and mc confluent; cell Cu open.

Range.—North America and Australia.

Only one species is present, *australis*, taken at Como, New South Wales.

Pachyneres australis Malloch.

Malloch, *Austr. Zool.*, iii, 1924; Hardy, *Ibid.*, iv, Pt. vi, 1927.

♂. Head black; occiput with short, appressed, pale hairs; eyes separated at the vertex by a little more than the width of the ocellar tubercle, which is black. Frons narrowing towards antennae, at the vertex being about one-third the width of the head; face below antennae about one-half the width of the frons at the vertex. Antennae black, typical, except that the style is wanting, the third segment covered with short, black hairs. Proboscis black, hardly exserted.

Thorax black, the humeral angles and sides yellow, covered with short, erect, pale hairs; scutellum black; pleurae black, the sclerites margined yellow; halteres brownish, the knobs yellow. Abdomen short and rather stout, the segments with a yellowish lateral mark, covered with sparse, pale hairs. Legs black, the apices of femora and bases of tibiae yellowish, covered with short, pale hairs.

Wings hyaline; Sc short, not reaching the costa. Length of body, 1·2 mm.; of wing, 1·3 mm.

Hab.—New South Wales: Como (December), Sydney (April).

It is possible that a new genus may be required for Malloch's species. Both the wing figures of Malloch and Greene show the vein Sc to be missing, and Malloch's description of the type species remarks on the absence of the thimble-like style on the third antennal segment. I have not seen the holotype, but an examination of a male, in the collection of the late Dr. Ferguson, shows the vein Sc to be present, though short, and the style to be wanting.

Subfamily Phthiriinae.

Hind border of the eyes not indented; eyes without a bisecting line; occiput not bilobate above and devoid of a central cavity; tibiae bare or only pilose, without spicules arranged in rows, but if spicules are present then the palpi are two-segmented; body usually not bristly; cubital fork narrow, if rather broad then the body is narrow and elongate.

According to Bezzi's key to the subfamilies, six genera belong to the Phthiriinae, viz., *Eclimus*, *Marmasoma*, *Geron*, *Acreotrichus*, *Phthiria* and *Gonarthus*. In his list of the world genera, Bezzi has placed both *Eclimus* and *Marmasoma* in the subfamily Cylleniinae, but in neither of these two genera is the occiput bilobate above or with a central cavity. In *Marmasoma* the occiput

is convex, and the only trace of a bilobation is that groove usually met with among the genera of the Bombyliinae. It compares favourably with the African genera *Nomalonia* and *Henica*, but the absence of the central cavity makes it at once distinct. Our species of *Eclimus* I have compared with a specimen of *E. lotus* Will., from America, and I find that generically they are all in complete agreement, and that in *lotus* also there is no bilobation or central cavity. *Marmasoma* and *Eclimus* are alike in having the body long and fairly narrow, the palpi two-segmented and a similar venation. *Marmasoma* can be easily distinguished by the bristly body and two-segmented style, but the two-segmented palpi in conjunction with the bristly legs should make it easy to place in the subfamily key. *Marmasoma* certainly seems to me to have a greater affinity with the Cylleniinae, but to avoid any difficulty in following the key I have placed it here.

Key to the Genera of the Phthiriinae.

1. Cell Cu open; palpi two-segmented 2
   Cell Cu closed; palpi one-segmented 4
2. Body very bristly; style two-segmented ..... *Marmasoma* White
   Body not very bristly; style one-segmented 3
3. Proboscis short and stout ..... *Gonarthus* Bezzi.
   Proboscis long and slender ..... *Eclimus* Loew.
4. M with only two branches ..... *Geron* Meigen.
   M with three branches 5
5. R_4 usually with an appendix; first antennal segment about twice the second; face of male and female with dense pubescence ..... *Acreotrichus* Macquart.
   R_4 usually without an appendix; first antennal segment but little longer than the second; face of male only with dense pubescence, that of female almost bare ..... *Phthiria* Meigen.

The genus *Gonarthus* is recorded from Australia for the first time. It is represented by one species, two specimens taken at Inglewood, Queensland, during September. Neither of these two specimens is in a good enough condition to describe. Bezzi's description of his genus is herewith appended. "This new genus was recently founded by me for my *Dischistus cylindricus*. The genus is distinct owing to its narrow and elongate, cylindrical body, devoid of strong bristles; the moustache is dense and soft; the occipital hairs are long and form a very dense crown. The eyes of the male are coalesced for a considerable distance and have the upper areolets enlarged; the frons of the female is rather narrow. The antennae are long, with the third joint linear and provided with a thin terminal style; the proboscis is rather short, and sometimes exceedingly short and thick; the palps are long, two-jointed, with the apical joint produced outwardly and thus at right angles with the basal one; the metapleura is bare; the legs have bristly hind femora, bristly tibiae and long pulvilli; the wings are short, destitute of a basal hook, comb, and alula. The first vein is straight and the marginal cell not dilated at end; discal cross vein placed on the last third of the discal cell; first posterior cell broadly open." (*Ann. S. Af. Mus.*, xviii, 1921, 88.)

Genus Geron Meigen.

Meigen, *System. Beschreib.*, ii, 1820, 223; White, *Proc. Roy. Soc. Tasm.*, 1916, 186; Hardy, *ibid.*, 1921, 65.

Genotype, *Bombylius hybridus* Mg.

Head about as broad as the thorax; ocellar tubercle rounded, and placed at the head vertex. Eyes in male contiguous, in female separated; frons much

reduced by the contiguous eyes in the male; face slightly projecting between the eyes, extending as a thin strip to the cheeks. Antennae approximate at base, longer than the head, the first segment long and cylindrical, with long hairs, the second short, about one-third the length of the first, the third longer than the first two segments together, spindle-shaped and without any style. Proboscis elongate and slender, much longer than the head; palpi small, one-segmented.

Thorax much arched, bearing long furry and short appressed pile, without any evident bristles; scutellum semicircular in shape, with similar pubescence. Abdomen somewhat conical in shape, decumbent, with dense erect and appressed tomentum and without bristles or bristly hairs. Legs long and slender, the tibiae only with minute spines, more developed on the hind tibiae; pulvilli present.

Wings strong; M with two branches only; cell Cu closed; cell R_5 broadly open.

Range.—World-wide.

This genus contains two species, *australis* and *nigralis*, the latter regarded as new. The former species is distributed over practically the whole of the continent and extends to Tasmania, the latter is known only from New South Wales and Queensland.

Key to the Species of Geron.

1. Wings with a broad, black, basal pattern, the apical half hyaline .... *nigralis*, n. sp.
   Wings hyaline or smoky with the base and fore margin brown .... *australis* Macq.

GERON AUSTRALIS Macquart.

Macquart, *Dipt. Exot.*, ii (1), 1840, 118; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 65.—*G. dispar* Macquart, *Dipt. Exot.*, suppl. 4, 1850, 122; White, *Proc. Roy. Soc. Tasm.*, 1916, 187.—*G. cothurnatus* Bigot, *Ann. Soc. Ent. France*, (7), lxi, 1892, 374.—*G. hilaris*, White, *Proc. Roy. Soc. Tasm.*, 1916, 188.

♂. Head mainly black; occiput with long, dense, yellow hairs, some long, black hairs adjacent to the hind eye margins; ocellar tubercle black, crowned with long, erect, black hairs. Eyes contiguous from the ocellar tubercle to near the antennal triangle. Frons much reduced by the contiguous eyes, with sparse black hairs and silver-white pile; face grey-dusted; beard short, yellowish, with few black hairs intermixed. Proboscis slender, black, about twice the head length; palpi short, black. Antennae black, of the form described in the generic characters, the first and second segments with long black hairs.

Thorax black with dense yellow erect and appressed golden pile; scutellum black with similar pubescence; pleurae blackish, the mesopleural tuft, long, dense and yellowish; halteres with pale stems, the knobs brown or blackish. Abdomen black with dense, erect, yellow, and appressed golden pubescence, the venter similarly clothed. Legs black, the coxae and femora with yellow hairs, the femora and tibiae with golden scales.

Wings hyaline or smoky, brown at the base and along the fore margin; vein enclosing cell mc apically, waved or straight; venation typical.

♀. Eyes well separated; posterior femora brownish, apex black, middle femora sometimes brownish; fore femora always black; otherwise similar to the male.

Length of body: 3·5–8 mm.; of wing: 3–7·5 mm.

Hab.—New South Wales: Linga (October), Glenreagh (January), Kenda (December), Kosciusko (February), Blue Mts. (January-April), Gordon (March),

Sydney (October-March), Ilford (December), Como (December), St. Marys (November), National Park (January-March). Queensland: Townsville (December), Gogango (June), Brisbane (January-March), Chinchilla (November-March), Eidsvold (October-March), Cairns. South Australia: Middleton, Adelaide. Western Australia: Zanthus (September). North Australia: Darwin (October). Tasmania: Hobart (January), Eaglehawk (April), Dunalley (February), Launceston (March), Geeveston (December), St. Patrick's Rv. (February).

In the series of eighty-seven specimens before me there is a wide range of variation in size and characters, and there do not appear to be any satisfactory characters whereby they may be divided into more than one species. The general pubescence is yellow erect and golden appressed, but in several specimens white hairs have become intermixed, and in sixteen of the series the pubescence is pure white. The wings show varying degrees of coloration, from being hyaline or smoky, brown at the base and along the fore margin, to clear hyaline, the clear wings being usually associated with specimens bearing white pile. White erected his species, *hilaris*, on specimens with clear white pubescence, completely hyaline wings, and the outer vein of cell mc straight. This latter character is also not constant and there are specimens with yellow hairs and smoky wings with this vein straight.

GERON NIGRALIS, n. sp.

♂. Head black; occiput covered with dense, erect, black hairs; ocellar tubercle black, crowned with long, erect, black hairs. Eyes contiguous as in *australis*. Frons greatly reduced by the contiguous eyes, with sparse black hairs and some silver white tomentum close to the antennae; face black between antennae and upper mouth borders, grey dusted towards the cheeks. Antennae black, segments one and two with stiff black hairs. Proboscis black and slender, about twice the head length; palpi small, black.

Thorax black, with an indistinct long median grey stripe and two short, admedian, similar stripes, covered in front and on the sides with dense, stiff, black hairs, and dorsally with short intermixed black and white tomentum; pleurae black, the mesopleural tuft black; halteres brown, the knobs yellow, black above. Abdomen black, with long dense whitish pile, yellowish at the base, and some intermixed black bristly hairs apically. Legs wholly black, the coxae and femora with black hairs.

Wings with the basal half black, the apical half hyaline, the colour clearing towards the lobe; cell M with a small hyaline spot; venation normal.

Holotype ♂, Hornsby, N.S.W., 9th December, 1923. Length of body, 6·5 mm.; of wing, 6 mm. Paratypes: 1 ♂, Sydney, 12th February, 1922, E. W. Ferguson; 1 ♂, Brisbane, December, 1926, G. H. Hardy; 1 ♂, Bunya Mts., Queensland, December, 1926, A. P. Dodd.

Here again a certain amount of variation is evident. The appressed pubescence may be golden or white, R_4 may be but gently curved or may embrace the wing tip, and in the male from the Bunya Mts. the black colour of the wings occupies more than the basal half, leaving that portion of the wing including cell Cu and the lobe faintly brown.

The holotype is in the Macleay Museum.

Genus PHTHIRIA Meigen.

Meigen, *Ill. Mag. Ins.*, ii, 1803, 268; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 66.

Genotype, *Bombylius pulicarius* Mg.

Head in male almost semicircular, in female somewhat pyriform; ocellar tubercle occupying the head vertex. Eyes in male contiguous or subcontiguous, in female widely separated. Frons broad, depressed medianly; face projecting, with dense pubescence in the male, sparse in the female. Antennae approximate at the base, not as long as the head, segments one and two subequal, the third elongate and, when viewed from the side, broadest medianly with the apex deeply concave, provided with a subapical style and usually bearing on its upper surface a number of erect hairs of median length, these hairs more prominent in the male. Proboscis long and slender, longer than the head, the labella not enlarged; palpi consisting of one segment, slender, porrect.

Thorax somewhat oval, longer than broad, slightly arched, with dense pubescence in the male, sparse and appressed in the female; pleurae with sparse hairs except for the dense mesopleural tuft; scutellum large and semicircular. Abdomen composed of seven visible segments, conical and densely pubescent in the male, usually broad and ovate, with the apical segments narrowly pointed and covered with sparse tomentum in the female. Legs slender, devoid of bristles, except for some tiny spicules on the hind tibiae; pulvilli present.

Wings strong; R_{2+3} and R_4 almost straight; M with three branches; the cubital fork narrow; cell Cu closed; cell R_5 open.

Range.—World-wide.

Two species are included, *hilaris* and *albocapitis*, the latter regarded as new. *P. hilaris* is known from every State on the Continent whilst *albocapitis* comes from the north-west of Western Australia.

Key to the Species of Phthiria.

1. Face and frons with dense black hairs in the male ..... *hilaris* Walker
   Face and frons with dense white hairs in the male ..... *albocapitis*, n. sp.

PHTHIRIA HILARIS Walker.

Walker, *Ins. Saund. Dipt.*, 1856, 194; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 66.—*P. lineifera* Walker, *Trans. Ent. Soc. Lond.*, iv, 1857, 146.—*P. pallipes*, Bigot, *Ann. Soc. Ent. France*, (7), lxi, 1892, 367.

♂. Head black, occiput with dense, equal, yellow hairs; ocellar tubercle black, crowned with erect, black hairs. Eyes contiguous from beneath the ocellar tubercle to near the antennal triangle. Face and frons grey-dusted, covered with dense, long, black pubescence. Antennae black, the first two segments and the third at about its middle, with long black hairs; style spine-like, subapical; beard whitish. Proboscis black, about twice the length of the head; palpi elongate and slender, about one-half the length of the proboscis, with sparse hairs.

Thorax velvety-black, covered with dense, yellow pile; scutellum black, with similar pile; pleurae greyish, the mesopleural tuft yellowish; halteres yellow, the knobs black; squamae blackish with a short, pale fringe. Abdomen black, the segments with yellow lateral margins, covered with long, dense yellow pile; venter mainly yellowish, the apical segments partly black. Legs black, the coxae and femora with long, yellow hairs.

Wings hyaline, the cell Sc yellow; venation typical.

In one male, Brookfield, Q., November, 1926, the yellow lateral margins of the abdomen are so large that the abdomen appears yellow with a row of central black spots and a black apex.

♀. Head mainly yellow, the occiput black with a broad yellow margin adjacent to the hind eye borders; ocellar tubercle black. Eyes separated at the vertex by about twice the width of the ocellar tubercle. Frons yellow, black near antennae, this area extending for about one-third the height and not reaching the eye margins on each side, covered with sparse, black hairs; face broad and yellow, clothed with sparse, short, erect, yellow hairs, which are mainly confined to the mouth borders, extending to the longer and denser, whitish beard below. Antennae black, the hairs on the third segment comparatively few, not so prominent as in the male.

Thorax black, greyish medianly and yellow laterally and posteriorly, the black area being joined to the black suture at the scutellum by a short neck; scutellum yellow, narrowly black at base, the whole with sparse yellow pile; pleurae partly grey and partly yellow with sparse yellowish hairs. Abdomen of the shape described in the generic characters, the basal segment yellow, the second mainly black, the remaining segments yellow with blackish incisions, the whole with sparse yellow pile. Legs yellow, with the coxae, bases of all femora, fore and hind femora above, apices of fore and middle tibiae, hind tibiae and all tarsi, black.

Wings as in male.

Length of body: ♂, 5–8 mm., ♀, 3–9 mm.; of wing: ♂, 4·5–6 mm., ♀, 3·5–8 mm.

Hab.—New South Wales: Roseville (October), Warialda (October), Nevertire (October), Blackheath (November), Lindfield (November), Woodford (November), Linga. South Australia: Middleton. Queensland: Westwood (October), Brisbane (October), Eidsvold (November), Brookfield (November). Western Australia: Merredin (August), Zanthus. Victoria: Timboon.

In the series of twenty females under examination there is a tremendous range in variation and it is possible that more than the one species is represented. The frons may be provided with a median black stripe, extending from the ocellar tubercle to the black area near the antennae. The yellow markings of the thorax may be diminished so that eventually only the humeral angles remain yellow. The scutellum may be wholly black. The abdomen may have the middle segments entirely yellow, the other segments as in the description; or it may be all yellow, the second segment with a rather large, median, black spot; or it may be black, the segments with narrow yellow posterior margins. Specimens with this latter character must, I think, represent a distinct species. The legs may have the femora all yellow, black at the bases only, the hind femora at the apex as well, or all femora, except at bases, and tibiae, except at apices, yellow, or as in the description, except that the fore femora may be black with yellow apices.

Phthiria albocapitis, n. sp.

♂. Head greyish; occiput covered with dense, white hairs; ocellar tubercle black, crowned with erect, pale hairs. Eyes as in *hilaris*. Frons short and broad, with dense, white hairs, somewhat sparse medianly; face covered with dense white hairs which are continued to the dense beard below. Antennae black, with black hairs, typical. Proboscis very elongate and slender, about three times

the length of the head, black; palpi slender, black, about one-fourth the length of the proboscis, with sparse pale hairs.

Thorax and scutellum black, covered with dense whitish pile; pleurae dark grey, the mesopleural tuft dense, long and whitish; halteres yellow; squamae pale with a sparse, short, white fringe. Abdomen short and broadly conical, black, the segments with grey posterior margins, increasing in size apically, and interrupted medianly, so that the abdomen appears grey, black at the base, with a broad black median stripe, the segments on each side of the stripe partly black; whole covered with dense, long, whitish pile; venter grey, with less dense and more appressed white pubescence.

Fore and middle legs with coxae and femora for two-thirds their length, apices of tibiae and all tarsi, black; apices of femora and remainder of tibiae yellowish; hind legs missing.

Wings hyaline, the cell Sc faintly yellow; r-m placed well beyond the middle of cell mc; R_4 meets the margin at the apex; venation typical.

Holotype ♂, King George's Sound, Western Australia. Length of body, 7·5 mm., of wing, 6·5 mm.

The holotype is unique and is in the Macleay Museum.

Genus Acreotrichus Macquart.

Macquart, *Dipt. Exot.*, suppl. 4, 1849, 121; Becker, *Ann. Mus. Zool. St. Petersb.*, xvii, 1912, 488; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 66.

Genotype, *Acreotrichus gibbicornis* Macquart.

Head semicircular in shape, about as broad as the thorax; occiput flattened, covered with dense pile. Eyes contiguous in the male, separated in the female. Face and frons broad, with dense erect hairs, the face projecting between the eyes, cushion-like laterally. Ocellar tubercle rounded and prominent, placed at the head vertex. Antennae approximate at base, porrect, not as long as the head, the first segment about twice the length of the second, both with long stiff hairs, the third longer than the first and second together, outwardly directed and, when viewed from the side, broadest medianly, the apex deeply concave, the concavity with a small, spine-like subapical style; gibbose and bearing about six to eight very long hairs at and above its broadest point. Proboscis long and slender, the labella not enlarged, much longer than the head; palpi slender, porrect, one-segmented, and a little less than half the length of the proboscis.

Thorax longer than broad, little arched, covered with long dense hairs in the male, less dense in the female; prealar bristles more prominent in the female; scutellum large and semicircular with similar pubescence; pleurae with a dense, mesopleural tuft. Abdomen consisting of seven visible segments, conical and densely pubescent in the male, broadly oval and much less pubescent in the female; no evident bristles. Legs slender, the tibiae with spicules, more developed on the hind tibiae; pulvilli present.

Wings strong; R_{2+3} and R_4 almost straight, the latter vein usually with a short backwardly-directed appendix; M with three branches; cell Cu closed; lobe and alula well developed.

Range.—North America and Australia.

This genus was erected by Macquart for the solitary species *gibbicornis* which, like *Phthiria hilaris* Walk., is remarkable in that the female differs so

much from the male that they were originally described as two distinct species. *Acreotrichus gibbicornis* is known from New South Wales, Queensland and Western Australia.

ACREOTRICHUS GIBBICORNIS Macquart.

Macquart, *Dipt. Exot.*, suppl. 4, 1849, 121; Schiner, *Reise Novara*, 1868, 138; Froggatt, *Austr. Insects*, 1907, 297; Becker, *Ann. Mus. Zool. St. Petersb.*, xvii, 1912, 488; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 66.—*Acreotrichus fuscicornis* Macquart, *Dipt. Exot.*, suppl. 4, 1849, 122; Froggatt, *Austr. Insects*, 1907, 297; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 66.—*A. inappendiculatus* Bigot, *Ann. Soc. Ent. France*, (7), lxi, 1892, 366.

♂. Head dark; occiput covered with dense, white to pale brownish hairs, with some longer black hairs adjacent to the hind eye-margins; ocellar tubercle black, with a number of long, erect, black hairs. Eyes contiguous or almost so for about one-third the frons. Frons and face broad, clothed with dense, erect, white hairs and longer encircling black hairs, the white hairs extending from the frons to the dense beard below, the frons also with silvery-white appressed tomentum above. Antennae of the form described in the generic characters, the hairs on the segments being black, those on the third segment very long; style subapical, spine-like. Proboscis black and slender, about twice the length of the head, the labella not enlarged and usually upraised; palpi black, about a little less than half the length of the proboscis.

Thorax black, covered with dense, long, whitish hairs, the pleurae, breast and scutellum with similar pubescence, the mesopleural tuft dense and long; the dorsum with few black bristly hairs intermixed; halteres brownish, the knobs black. Abdomen black, clothed above and on the sides with dense, long, whitish hairs, with some intermixed, longer, bristly hairs, especially towards the apex; venter with less dense pubescence. Legs blackish, the coxae and femora with long white hairs; the femora and tibiae with whitish scales.

Wings light smoky, the base and fore margin to about the apex of the vein Sc yellowish, the colour diffusing inwardly; R_4 usually with an appendix; venation normal.

♀. Occiput black with a yellow border adjacent to the hind eye-margins, the pubescence shorter and less dense than in the male. Eyes separated at the head vertex by about two and one-half times the width of the ocellar tubercle. Frons black, the antennal tubercle somewhat yellowish, with short black hairs; face yellow to grey, with similar but less dense pubescence to that in the male.

Scutellum yellow-margined, the pale prealar bristles visible. Abdomen black, the segments with brownish posterior borders, the pubescence limited to white and yellow, appressed pile and sparse, long, white hairs, more prominent laterally. Legs black, the knees of the fore and middle tibiae, brown.

Length of body, 4–8 mm.; of wing, 3–6 mm.

Hab.—New South Wales: National Park (August), Sydney (September), Myall Lakes (September), Gordon (March), Woy Woy (September), Guildford (September), French's Forest (September) and Hawkesbury River. Queensland: Gayndah (August), Eidsvold (August), Inglewood (September). Western Australia: Eradu (September), Perth (October), Tammin (August).

Included in the series of this species are seven specimens (5 ♂, 2 ♀) from Western Australia, which possess spotted wings, but differ in no other way from

gibbicornis. In two of these, the spots are but faintly discernible and I prefer to regard them as a variety, rather than as a distinct species.

Genus Eclimus Loew.

Loew, *Stett. Ent. Zeit.*, v, 1844, 154; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 63.

Head about as broad as thorax; occiput inflated, but not much so. Eyes usually contiguous in the male, separated in the female, their upper facets enlarged. Ocellar tubercle rounded and prominent and placed at the head vertex. Frons small; face much projecting between the eyes, the cheeks narrow. Oral opening containing a large rounded tubercle, which bears a sparse moustache. Antennae approximate at base, about as long as the head; first segment long and cylindrical, the second short, the third about as long as the first and second together, somewhat elongate-conical in shape, with or without a very minute terminal style. Proboscis long and slender, the labella little enlarged; palpi two-segmented, the first segment ribbon-shaped, the second somewhat lanceolate and about one-half to one-third the length of the first.

Thorax convex, muricate in the males only, the bristles weak, covered with depressed tomentum and sparse erect hairs; scutellum semicircular in shape, with thin, marginal bristles; squamae small, with a sparse fringe; halteres long and slender. Abdomen long and slender, decumbent, and composed of eight visible segments in the male, the ninth with the genitalia, and seven in the female, the eighth with the genitalia; tomentum consisting of depressed and erect pile, sometimes tuft-like apically. Legs long and slender, the hind pair especially so; spines on the tibiae small and weak; pulvilli present, weak.

Wings always with a diminished alula and sometimes with the lobe partly cut away; costa denticulate in the males only, smooth in the females; M with three branches; cells R_3 and R_4 undivided; cell mc long and narrow, sometimes angulated below; R_{2+3} gently curved at the apex, never looped; cells R_5 and Cu open; Cu_2 incomplete; R_4 S-shaped.

Range.—Europe, North America and Australia.

This genus comprises three species, two of which are regarded as new. Sexual dimorphism is here well illustrated. In the male the thorax is muricate, the costa denticulate, and the abdomen consists of nine segments, whilst in the female both the thorax and costa are smooth and the abdomen consists of eight segments. In one species, *nigrapicalis*, a further difference in the sexes is shown by the coloured wing of the male and the hyaline wing of the female.

Distribution.—As yet the only species that does not appear confined to Queensland is Hardy's *longipalpis*, the type of which was described from Botany Bay, New South Wales.

Key to the Species of Eclimus.

1. Wing darkened along the costal border to the apex ..... *furvicostatus*, n. sp.
   Wings not as above 2
2. Small species, the female with similar wing markings to the male, these markings consisting of a large blotch extending from the apex to about one-third the costal border, and a small blotch near the base of the vein R_{2+3} .... *longipalpis* Hardy.
   Large species, the male with a single blotch in the wing, the female with clear wings ..... *nigrapicalis*, n. sp.

Eclimus nigrapicalis, n. sp.

♂. Head grey; occiput covered with erect white hairs, which conceal two rows of short black bristles, with another row of bristles close to the eye-margins;

ocellar tubercle black with some long, erect, black hairs. Eyes approximate, being separated at the narrowest point by a distance equal in width to the fore ocellus. Frons greyish, small; face with white hairs on either side and some sparse black hairs between the mouth borders and antennae; oral tubercle with a moustache of long white hairs. Antennae black, the first two segments grey-dusted, with short black hairs, the third with a microscopic apical spine. Proboscis black, about twice the head length; palpi black, not quite half as long as the proboscis.

Thorax dark brownish, grey laterally and with two admedian grey stripes; mesonotum definitely muricate, especially along the grey stripes, the whole bearing depressed white pile and some sparse intermixed black and white hairs; bristles pale brownish; scutellum dark greyish, with appressed grey pile and thin, black, marginal bristles; pleurae and breast grey, sparsely white haired; squamae brownish with a thin white fringe; halteres pale brown with black knobs. Abdomen black, covered with appressed black pile, the incisions with narrow bands of white pile, the black pubescence becoming longer and denser towards the apex; the seventh segment with white pile; laterally there are clear white hairs extending to the fifth segment, the apical segments being covered with dense black hairs, which have the appearance of tufts; the eighth segment bears some long, dense, silver-white hairs; venter grey, with white hairs, apically black-haired. Legs black, the coxae grey with white hairs, the femora with appressed white pile; spines weak and black; pulvilli pale.

Wings hyaline with a single large fuscous blotch placed at about two-thirds the length of the costal border and extending to r-m, its outlines much suffused; venation typical.

♀. The female differs from the male in having completely hyaline wings and in having the eighth segment devoid of the silver hairs found in the male.

Holotype ♂, Goondiwindi, Queensland, 29th December, 1927, F. Roberts; allotype ♀, similar data. Length of body: ♂, 12 mm.; ♀, 10 mm.; of wing: ♂, 9 mm.; ♀ 7·5 mm. Paratypes: 6 ♂, Goondiwindi, December and January, 1927, F. Roberts; 6 ♂, Goondiwindi, G. R. Bassingthwaighte; 1 ♂, Eidsvold, Bancroft (no date); 1 ♂, Rockhampton (no date). Other specimens in the series examined were captured at Westwood and Chinchilla, Queensland, in November and February.

All the specimens from Goondiwindi were taken in the one spot, hovering over a decaying log. The difference in the wings of the male and female is remarkable and, although no pairs were captured *in cop.*, I do not think that there is any doubt as to the sexes, as they were all taken at the same time and in the same place and no males are known with a completely hyaline wing and no females with a darkened wing. The blotch in the wing of the male does, however, vary in intensity and in the specimens from Eidsvold and Rockhampton it is very faint.

The holotype and allotype are in the Queensland Museum.

Eclimus longipalpis Hardy.

Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 63.

♂. Head grey; occiput covered with white hairs; ocellar tubercle black with a few erect black hairs. Eyes contiguous near the ocellar tubercle. Face much projecting between the eyes, almost bare, the beard being white; oral tubercle with a moustache of white hairs. Antennae with the first two segments grey-

dusted, the third normal, i.e., about as long as the first and second segments together, rather stout, broader than the second segment and with what appears to be an extremely minute apical spine. Proboscis black, about twice the length of the head; palpi black, about one-half the length of the proboscis.

Thorax black, covered with appressed black and golden pile, the latter more or less confined to the middle line; pleurae and breast grey with white hairs, more abundant on the mesopleurae; scutellum black, margined grey, the grey being continued laterally to the humeral callus; bristles thin, pale; squamae with a sparse white fringe; halteres brownish. Abdomen black, covered with black tomentum, the incisions with white pile; from the third segment the black pile becomes bristle-like and on the apical segments it is longer and more erect; venter grey, white tomentose, except towards the apex. Legs with the coxae grey, otherwise black, covered with white tomentum, the coxae and femora with white hairs.

Wings hyaline, with a small fuscous blotch at the base of the vein R_{2+3} and another larger blotch at the apex, the latter bounded by the vein R_4 and the veins at the bases of the cells M_1 and 2nd M_2, from the latter reaching the costa in an almost straight line; venation normal.

♀. Similar to the male, except for the usual sexual differences.

Allotype ♀, Westwood, Queensland, November, 1927, A. P. Dodd. Length of body, 5·5 mm.; of wing, 4·5 mm.

The species was described by Hardy from a single male specimen, which he made the holotype.

Hab.—New South Wales: Botany Bay. Queensland: Westwood (November), Chinchilla (April).

Hardy was correct in assuming that the third antennal segment of his holotype was abortive. In his description of the species he says "third joint scarcely longer than the second, the apex is truncate, receding from the dorsal to the ventral surface, and the edge appears to be crowned with minute spines". The third antennal segment of the three specimens (1 ♂, 2 ♀) before me is normal in every way.

The allotype is in the Australian Museum.

Eclimus furvicostatus, n. sp.

♂. Head grey; occiput covered with short, erect, white hairs, which are extended to the chin to form a sparse beard. Eyes contiguous for a short distance below the ocellar tubercle; frons small, apparently bare; face with a few short black hairs; oral tubercle with a moustache of white hairs. Antennae not as long as the head, the first two segments grey-dusted and covered with short, appressed, black hairs, the third black and provided with a microscopical spine. Proboscis black and slender, about twice the head length; palpi black, not quite half the length of the proboscis.

Thorax dark brown, grey laterally and posteriorly, clothed with appressed black and white tomentum and sparse hairs; prealar bristles brown; scutellum grey-margined, with similar tomentum and thin, pale, marginal bristles; pleurae and breast grey with sparse white hairs; halteres pale brown with blackish knobs; squamae brown with a sparse white fringe. Abdomen black, clothed with appressed black pile, the incisions of segments one to five with grey pile, which is also prominent on the sides, intermixed with erect white hairs; apical segments

apparently with black tomentum only; venter with grey pile. Legs with grey coxae, the fore femora and all tarsi black, the remainder somewhat brownish; tomentum consisting of white hairs and greyish pile; pulvilli weak, pale.

Wings hyaline, the fore margin to the apex brown, the colour expanding from the almost hyaline base to the cross-vein r-m, being bounded by the vein R_4, and leaving a large hyaline area which extends from r-m to near the base of the vein R_4; cell mc very long and narrow, somewhat angulated below.

Holotype ♂, Westwood, Queensland, November, 1927, A. P. Dodd; allotype ♀, Stanthorpe, Queensland, 27th January, 1927. Length of body: ♂, 13 mm., ♀, 12 mm.; of wing: ♂, 10·5 mm., ♀, 9·5 mm. Paratype: 1 ♂, as with allotype.

The holotype and allotype are in the Queensland Museum.

Genus Marmasoma White.

White, *Proc. Roy. Soc. Tasm.*, 1916, 188; Hardy, *ibid.*, 1921, 63.

Genotype, *M. sumptuosa* White, by original designation.

Head somewhat globular in shape, almost equal in breadth to the thorax; occiput inflated, with long hairs and short bristles; ocellar tubercle prominent and placed at the head vertex. Eyes large, contiguous in the male, separated in the female; frontal triangle rather long but narrow; proboscis longer than the head, slender; palpi slender, two-segmented. Antennae longer than the head, approximate at the base, the first segment long and cylindrical, the second short, about one-third the length of the first, the third constricted at the base, very slightly expanded, almost as long as the first two segments together and provided with a slender two-segmented style of about one-third its length.

Thorax convex, bearing numerous long bristles and clothed with scales and long bristly hairs; scutellum semicircular in shape, also with long bristles. Abdomen in male of an elongate-conical shape with an upraised apex, composed of nine visible segments; in the female broadest medianly and apically pointed; tomentum consisting of scales and long hairs. Legs long and slender, the posterior femora with many, middle femora with few stout spines beneath; tibiae with numerous stout spines, more developed on the hind tibiae; tarsi long, the joints marked by spurs; pulvilli present, weak.

Wings with the lobe somewhat diminished and the alula rather small; R_{2+3} but gently curved at the apex; cell mc somewhat angulated below, the angle frequently marked by a recurrent veinlet; cell R_5 open; cells R_3 and R_4 without interrradials; cell M much longer than cell R.

Range.—Australia.

Marmasoma is represented by a solitary species, *sumptuosa*, which is recorded from Tasmania and mountainous portions of South-Eastern Australia.

Marmasoma sumptuosa White.

White, *Proc. Roy. Soc. Tasm.*, 1916, 190; Hardy, *ibid.*, 1921, 63.

♂. Head mainly greyish; occiput darker above, clothed with brownish scales, very dense at the hind eye-margins, and long, dense, light brown hairs, with a row of short, strong, black bristles above. Eyes contiguous from below the ocellar tubercle to near the antennal triangle; frontal triangle with dense, pale scales; face rather narrow, covered with pale scales and hairs; chin with a thin whitish beard; mouth opening rather broad, the cheeks much reduced. Antennae black, the first segment with long pale and short black hairs, the third segment bare with

a distinctly two-segmented style. Proboscis black, about one and one-half times the head length; palpi brownish, about one-fourth the length of the proboscis.

Thorax blackish, with two admedian greyish stripes and greyish margins, the black area appearing clothed with appressed yellow scales, the grey with whitish scales, the whole with sparse, short, whitish hairs, densest laterally; prothoracic spines strong and brown, remaining spines and bristly hairs, black; scutellum with median, dense golden or brownish scales, marginal white scales and hairs and well developed, black, marginal bristles; pleurae greyish, the sutures somewhat depressed, with sparse white scales and hairs; halteres with brownish knobs; squamae pale with long, sparse, whitish hairs. Abdomen of a dark brown ground-colour, clothed with dense, brownish scales, the incisions with narrow bands of white pile; a row of dark brown centre spots present, the whole with scattered black hairs, the first segment only with white hairs. Legs with the elongate coxae light brown, the femora black, the tibiae brownish, the tarsi darker, clothed with brownish scales; spines black; pulvilli pale.

Wings hyaline, the costal cell yellowish, the costal margin otherwise brownish, the colour being dilated from the base to reach r-m, where it is concentrated into a large rounded spot; hyaline area with dark brown spots on the angulated portion of cell mc, at the apex of cell M, near the apex of vein R_{2+3}, and two on R_4.

♀. Similar to the male except for the generic differences of the eyes and abdomen; the frons with numerous long curved bristles.

Length of body, 8·5–11 mm.; of wing, 7–9·5 mm.

Hab.—Tasmania: Hobart, Bagdad (November), Tyenna (December). New South Wales: National Park, Mt. Kosciusko (November).

Subfamily Usiinae.

Eyes with the hind borders entire, the occiput devoid of a bilobation and a central cavity; tibiae usually not bristly, but if bristles are present, then the palpi are two-segmented. Cubital fork broad; if it is rather narrow then the body is short and broad.

This subfamily was overlooked in my general notes on the Bombyliidae and has been omitted from the subfamily key. The Usiinae are placed next to the Phthiriinae, from which they may usually be distinguished by the broad cubital fork. Thus out of the thirteen subfamilies recognized by Bezzi the Australian region contains ten.

Only one genus is included, *Eusurbus*, which is new and is erected for Macquart's *Bombylius crassilabris*. This species, although it resembles the species of *Dischistus* in its bristly body and venation, is distinct from the Bombyliinae on account of its two-segmented palpi.

Both species are readily attracted by flowers, but beyond this nothing is known of the adult habits or life histories.

Genus Eusurbus, n. gen.

Genotype, *Bombylius crassilabris* Macq.

Head broad and semicircular; occiput moderately convex, covered with dense hairs and intermixed bristles. Eyes reaching the full height of the head, somewhat narrow, contiguous or subcontiguous in the male, separated in the female; ocellar tubercle very large, rounded, occupying the head vertex. Frons concave, the antennal tubercle separated by a distinct groove; face projecting between

the eyes, covered with a dense brush of hairs, the antennae placed on its upper and outer edge; oral opening large and broad, its borders raised and separated from the face by deep grooves. Antennae approximate at the base, about as long as the head; first segment long and cylindrical, second short, about one-third the length of the first, the third as long as the first and second together, sometimes longer, constricted at the base, apically pointed, the style spine-like, apical or subapical. Proboscis longer than the head, somewhat stout, the labella much enlarged; palpi short and curled, two-segmented, the second segment about one-fourth the length of the first.

Thorax broad, flattened or slightly humped, covered with dense erect and appressed pubescence, the bristles small but distinct; pleurae and breast densely haired; scutellum rather small; halteres small; squamae with a long and dense fringe. Abdomen broad and rounded, consisting of seven visible segments, the eighth with the genitalia, covered with dense erect and appressed pile with long bristly hairs intermixed. Legs slender, the tibiae bristly, the middle and hind femora sometimes with short spines below; pulvilli present.

Wings strong; M with three branches; R_{2+3} curved at the apex, sometimes looped; cell mc acute at base, broad and rather short; cross-vein r-m placed well below its middle, so that cell R_5 is short; cells R_5 and Cu open, the latter sometimes narrowly so.

This genus is represented by two species, the genotype and *nigracinctus* which is recorded as new. This black banded species is known from Western Australia only, whilst *crassilabris* comes from New South Wales and Queensland, its record from Western Australia being rather doubtful.

Key to the Species of Eusurbus.

1. Body covered with brownish pubescence; legs brownish ..... *crassilabris* Macquart.
   Body covered with grey and black pubescence, forming bands on the abdomen; legs black ..... *nigracinctus*, n. sp.

EUSURBUS NIGRACINCTUS, n. sp.

♂. Head dark; occiput covered with dense, equal and erect, whitish hairs, with many black bristles intermixed; ocellar tubercle black, crowned with erect black hairs. Eyes contiguous for some distance below the ocellar triangle. Frons broad with grey pile; face very broad, with long, erect, black hairs and shorter white pile, the latter confined to that portion of the face between the upper mouth borders and antennae and continued around the mouth borders themselves, the former encircling the white hairs. Antennae with the first two segments grey-dusted and bearing black hairs, longer beneath, intermixed with short white hairs, the third segment as long as the first two together and provided with a distinct style placed on the apex. Proboscis black, somewhat longer than the head, the labella much enlarged; palpi black, with long hairs below and at the apex.

Thorax black, about as broad as long, covered with grey appressed and intermixed grey and black, short, erect pile; bristles short and black; pleurae and breast with dense black and intermixed grey hairs; scutellum brownish with grey tomentum and long, thin, black, marginal bristles; squamae with a dense, long, yellowish fringe; halteres small, obscure yellow. Abdomen very broad, covered with dense, black and grey pubescence, with many intermixed black, bristly hairs; the black hairs are arranged as narrow bands, the apical one short and not reaching the sides; laterally with clear white pile basally, the remaining

segments with dense, black and grey tufts, which are a continuation of the grey and black dorsal bands; apical segments mainly with grey hairs, black tufted laterally; venter mainly grey tomentose, the apical segments black tomentose. Legs black, the coxae and femora white haired, the femora and tibiae with grey appressed pile; middle and hind femora with few and many black spines below. Wings hyaline, brownish at the base and for a short distance along the fore margin; R_{2+3} curved but not looped; basal vein of cell M_1 very small; cell Cu narrowly open.

♀. Eyes separated at the vertex by about twice the width of the ocellar tubercle, the broad frons with grey and black hairs.

Holotype ♂, Wyalkatchem, W. Aust., 1st September, 1926, E. W. Ferguson; allotype ♀, Eradu, W. Aust., 8th September, 1926, A. J. Nicholson. Length of body: ♂, 13 mm.; ♀, 13 mm.; of wing: ♂, 12 mm.; ♀, 12 mm. Paratypes: 1 ♂, Wyalkatchem, W. Aust., 30th August, 1926, A. J. Nicholson; 3 ♂, 2 ♀, Kojarena, W. Aust., September, 1926, A. J. Nicholson; 4 ♂, 5 ♀, Kojarena, September, 1926, E. W. Ferguson; 1 ♂, 1 ♀, Merredin and Moora, W. Aust., L. J. Newman. There is another ♀, captured by E. W. Ferguson at Canna, W. Aust., during September.

In many specimens the black hairs predominate on the thorax, in others the white hairs are more distinct. In the latter case, the white hairs are dense over the pleurae and breast and descend over the wing base to the sides of the first abdominal segment.

The holotype and allotype are in the Macleay Museum.

Eusurbus crassilabris Macquart.

Bombylius crassilabris Macquart, *Dipt. Exot.*, suppl. 5, 1854, 77.—*Dischistus crassilabris* Schiner, *Reise Novara*, 1868, 138; Hardy, *Proc. Roy. Soc. Tasm.*, 1921, 68.

♂. Head greyish; occiput moderately convex, covered with dense, erect brownish hairs, with many brown and black bristles intermixed, the tomentum near the eye-margins being also golden and appressed. Eyes approximate for a short distance below the ocellar triangle, the upper and inner facets enlarged; ocellar tubercle large, black, with black hairs, those in front being very long and directed forward. Frons with a faint median groove, with appressed golden tomentum and black hairs; face very broad, with short brown hairs, longer above, and numerous long, erect, black hairs close to the inner eye-margins and continued almost to the whitish beard below. Proboscis rather stout, rarely fully exserted, but when so, about twice the head length, the labella much enlarged; palpi short, black, with sparse long hairs at the apex and below. Antennae with the first two segments grey-dusted and bearing short black hairs above and long brownish hairs below, the third segment black, much longer than the first two segments together, with a minute, subapical, spine-like style.

Thorax black, moderately humped, covered with dense, short, pale and intermixed hairs which, viewed from above, have an almost whitish appearance laterally and, when viewed from the front, the whole has a whitish sheen; appressed golden tomentum also present; bristles short, reddish; scutellum brownish with similar pubescence to the thorax, the marginal bristles thin and reddish; pleurae and breast densely white-haired, the breast and mesopleural tuft with intermixed reddish hairs; halteres with yellowish knobs, black above; squamae with a long, dense, pale fringe. Abdomen very broad, but usually longer

than broad, covered with appressed golden tomentum and long brownish hairs, densest on the sides, with numerous longer, black, bristly hairs intermixed; venter mainly white-haired with intermixed pale bristly hairs. Legs with the coxae and femora at the base black; femora brownish or reddish; tibiae and tarsi darker; coxae and femora with white hairs, tibiae and femora with white appressed tomentum.

Wings subhyaline, brown at the base and along the fore margin; R_1 meets the costa close to Sc; R_{2+3} is looped apically, the loop being longer than deep, the ascending arm straight, the base of the loop sometimes with a small appendix; R_4 sometimes with a small appendix placed on its first crest; alula rather small.

♀. Similar to the male except for the broadly separated eyes, the frons bearing golden tomentum, white near the antennae, and black hairs.

Length of body, 9–13 mm.; of wing, 8·5–12 mm.

Hab.—New South Wales: Guildford (October), National Park (July), Lindfield (September), Sydney, Toronto, Ballina. Queensland: Brisbane (September), Chinchilla (September).

Among the many specimens examined are two males from Perth, W. Aust., in which the pubescence is much lighter, almost golden, and the fore and middle femora are black with short black spines beneath. In none of the specimens from New South Wales and Queensland are the femora black or possessing spines beneath. I am inclined to think that these two Bombyliids represent Walker's *altus*, but refrain from a determination until more specimens are available.

The genotype has been deposited in the Queensland Museum.

AUSTRALIAN MYCETOPHILIDAE.

Synopsis of the Genera.

By A. L. Tonnoir.

Entomological Division, Canberra.

(Communicated by A. J. Nicholson, D.Sc.)

(Plates xxii-xxiii, and seven Text-figures.)

[Read 27th November, 1929.]

Before Skuse started to publish the results of his study of the Australian Mycetophilidae in 1888, very little was known about them. Four species only had been made known by Walker, one, *Platyura magna*, from the mainland (*List Dipt. Brit. Mus.*, 1848) and three others from Tasmania, *Sciophila par*, *Leia fulva* and *Mycetophila aequalis* (*Insecta Saund.*, 1856). On account of Walker's indifferent descriptions, none of these species seems to have been recognized subsequently by Skuse or others.

Skuse's work on the family (including the Sciarinae which he considered as a separate family) was embodied in four papers [These Proceedings, Vol. 3, 1888, 657-726 (Sciarinae), and 1123-1222 (rest of the subfamilies); and Vol. 5, 1890, 373-412 (Sciarinae, 390-412) and 595-640 (remaining subfamilies)].

The first paper (referred to in the following text as Skuse, 1888*a*) was accompanied by Plate xi, the second (referred to as Skuse, 1888*b*) by Plates xxxi and xxxii, and the fourth (referred to as Skuse, 1890*b*) by Plate xix.

Skuse's study embraced twenty-six genera of the Mycetophilidae, including 113 new species, half of which, however, belong to the genus *Sciara*. Among these twenty-six genera, fifteen were described as new and as being peculiar to Australia. However, since then, several of these genera have been recognized in other parts of the world and two of them fall in synonymy with well-known cosmopolitan genera. The types of the species described in the first paper by Skuse are in the Macleay Museum, Sydney, and those described in the supplements are in the Australian Museum, Sydney, both series being in excellent condition.

Since Skuse's time, very few workers have paid any attention to the Australian Mycetophilidae. F. W. Edwards, in a study of the subfamily Ditomyiinae, described two species of *Centrocnemis* (*Ann. Mag. Nat. Hist.*, (9), 7, 1921, 434-435) from Tasmania; in 1924, a wingless Sciarid inquiline in termites' nest, *Austrosciara termitophila*, has been made known by Schmitz and Mjöberg (*Ark. f. Zool.*, 16, No. 16, 1-3); and in 1925, Dr. E. W. Ferguson published (Proc. Linn. Soc. N.S.W., l, 487) the description of a Tasmanian species of *Arachnocampa*, a genus known till then only from New Zealand.

In these Proceedings (liii, 1928, 599) J. R. Malloch published a table to the genera of the subfamily Ceroplatinae in which the Australian genera were specially considered; however, as this work had been done without knowledge of what had been published by Edwards and myself, Malloch later gave corrections

to this key (*l.c.*, liv, 1929, 107). Edwards took up again quite recently (*l.c.*, liv, 1929, 162-175) the study of this subfamily, his main object being the splitting of the genus *Platyura* in nineteen subgenera, describing at the same time four new Australian species of this genus.

In the course of a collecting trip to Tasmania in 1921-22, I had the opportunity of collecting a large number of Mycetophilidae, the nature of the country and its relatively moist climate being much more favourable to the development of an abundant Mycetophilid fauna than the Australian mainland.

In attempting to classify this material, it was soon apparent that many more genera were represented in it than Skuse had recognized in his own collection. As I had no access to Skuse's types, I proposed to the late Dr. Ferguson to work out the Australian Fungus Gnats in collaboration with him, he being entrusted with the revision of the types, and I mostly with the generic part of the work. Unfortunately, his untimely death cut this project short. Until further opportunity occurs of studying Skuse's types, I am presenting now only a synopsis of the genera of the Australian Mycetophilidae as an introduction to the revision of the family, and also because Skuse's papers did not contain any key to the genera. I hope that the key I give here will be helpful to the Australian students; it is mostly based on that published in 1925 by F. W. Edwards (*Trans. Ent. Soc. Lond.*) and on that which Edwards and I built up for the New Zealand Fungus Gnats (*Trans. N.Z. Inst.*, 56, 1926). To make the work as complete as possible this key not only contains the genera recognized from Australia, but also those from the rest of the world, as some of these are likely to be found in this country sooner or later.

To establish the validity of the new genera proposed in the course of this study, I have had to describe a genotype for each, but otherwise I have refrained from describing new species until Skuse's types could be examined.

The structure of the hypopygium of only the little characteristic species is here given.

I am very much indebted to Dr. A. J. Nicholson for the loan of a good series of Skuse's paratypes from the Macleay Museum. These have been most helpful in settling many points of generic importance, but I do not think that in all cases one could rely on them to get a definite idea of Skuse's species, as in many more or less obscure forms a confusion of species is certain to have occurred, the more so because Skuse did not make any detailed study of the genitalia. I am further greatly indebted to Dr. A. J. Nicholson and Dr. I. M. Mackerras for submitting a small but interesting collection of Fungus Gnats from New South Wales, which contained some new generic forms, and amongst others a most remarkable one mimicking a wasp.

The number of Australian genera recognized here amounts to forty-seven. They can be listed as below. The number of species described, or else undescribed but known in collections, is given for each genus and the genera which have not been recorded from Australia before are preceded by an asterisk.

Ditomyiinae: *Centrocnemis* Phil. (8 species).

Diadocidiinae: **Diadocidia* Ruthe (1).

Macrocerinae: *Macrocera* Mg. (3).

Ceroplatinae: *Arachnocampa* Edw. (1); *Antriadophila* Skuse (4); *Pseudoplatyura* Skuse (1); **Neoantlemon*, nov. (1); **Nicholsonomyia*, nov. (1); *Ceroplatus* Bosc. (4); *Platyura* Mg. (15).

Lygistorrhininae: *Lygistorrhina* Skuse (1).

Sciarinae: *Sciara* Mg. (63); *Zygoneura* Mg. (1); *Trichosia* Winn. (1); *Austrosciara* Sch. and Mjb. (1).

Sciophilinae.

Mycomyiini: *Mycomyia* Rd. (*Sciophila* Sk. *nec* Winn.) (18); *Neompheria* O.-S. (1).

Sciophilini: **Pareudicrana*, nov. (2); **Allocotocera* Mik. (2); **Neoallocotocera*, nov. (1); **Tasmanina*, nov. (2); **Aneura* Marsh. (1); **Phthinia* Winn. (1); *Stenophragma* Skuse (3); **Sciophila* Winn., Subgen. *Austrosciophila*, nov. (1); *Trizygia* Skuse (3); **Paratrizygia*, nov. (1); *Aphelomera* Skuse (3); **Paramorganiella*, nov. (1).

Gnoristini: **Synapha* Mg. (1); **Austrosynapha*, nov. (1); **Pseudalysiinia*, nov. (1).

Leiini: *Clastobasis* Skuse (1); *Ateleia* Skuse (1); *Leia* Mg. (1); *Acrodicrania* Skuse (Incl. *Anomalomyia* Hutt.) (10); **Paraleia*, nov. (1); **Tetragoneura* Winn. (3).

Mycetophilinae: *Exechia* Winn. (*Brachydicrania* Sk.) (4); **Rhymosia* Winn. (*Synplasta* Sk.) (2); **Allodia* Winn. (1); *Dynatosoma* Winn. (1); *Trichonta* Winn. (2); *Mycetophila* Mg. (15); *Delopsis* Skuse (1); **Zygomyia* Winn. (1); *Sceptonia* Winn. (1).

A perusal of this list of genera will show that all subfamilies of the Mycetophilinae are represented in Australia, with the exception of the Boletophilinae and Manotinae; the latter may sooner or later be found here, as the genus *Manota* is known from New Zealand.

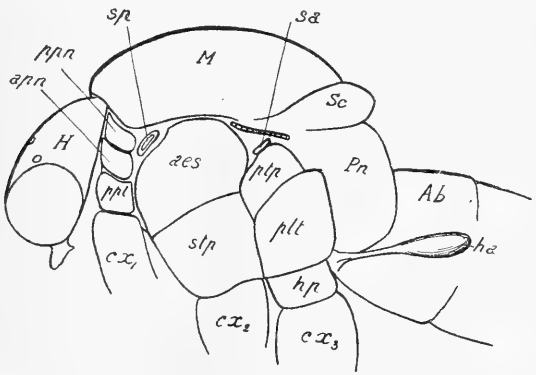
What is rather striking in this ensemble is the mediocre development of the most primitive groups like Ditomyiinae with only eight species as compared with twenty-six from New Zealand, and the Macrocerinae with three species, whereas eighteen, distributed in two genera, are known in New Zealand, and that *Macrocera* is abundantly represented in nearly all parts of the world. Other features of this fauna are the large development of the Sciarinae and the comparatively large number of genera in the Sciophilinae which are mostly monotypic. This last feature is also noticeable to a marked degree in the New Zealand fauna and may be, of course, due to the fact that we assign much too narrow limits to the generic concepts in this group, the distinction between genera being often based on a single venational character like the distal or proximal position of a fork. A number of the original generic divisions have been established by the old authors who had before them an incomplete fauna of one part of the world only, but as our knowledge extends to that of other regions, intermediate forms are found which do not enter within the known generic concepts. Unfortunately, in order to receive these forms, the trend has been in Mycetophilid studies to multiply the genera rather than to lump them, and now there is nothing left but to continue this method until our knowledge of the whole world fauna will allow lumping, based on a better understanding of the main taxonomic characters. I think that a closer study of the morphology of the head and its appendages could, to a certain extent, give a better base of classification than the wing venation in certain groups. Unfortunately, the morphology of the head has been often ignored in many of the genera established in the past.

The Australian Sciophilinae exhibit more marked affinities with those of New Zealand than I thought when studying the New Zealand Fungus Gnats (*Trans. N.Z. Inst.*, 56, 1926, 753), because at the time the Australian forms were not

as well known to me. The genera *Aneura*, *Phthinia*, *Aphelomera*, *Acrodicrania* and *Tetragoneura* are common to both countries. The subfamily Mycetophilinae is represented by a comparatively small number of species; *Mycetophila*, which is everywhere so abundant, and especially so in New Zealand, contains only about fifteen species and *Zygomyia* only one; on the other hand, the number of genera in that subfamily is noticeably greater in Australia than in New Zealand.

In order to allow non-specialists in the group to classify their material from the key here given, a few words on the nomenclature used may be necessary, inasmuch as I adopt here for the first time the wing venation nomenclature amended by R. J. Tillyard as far as the limit of M and Cu is concerned.

The costa either stops at the tip of R_5 or is produced beyond it, but never reaches the tip of M_1. Sc is more or less elongated, but often very short, and then it is interrupted; when it is complete it mostly joins the costa, but sometimes it ends in R_1; Sc_2 can be placed anywhere from near the base of Sc_1 to near its tip; it is often absent.



Text-fig. 1.—Thorax of a Mycetophilid seen from the side. *apn* and *ppn*, anterior and posterior divisions of the pronotum which are often fused together; *ppl*, propleura; *stp*, sternopleurite; *aes*, anepisternite; *ptp*, pteropleurite; *plt*, pleurotergite; *hp*, hypopleurite; *pn*, postnotum; *Sc*, scutellum; *M*, mesonotum; *H*, head; *Ab*, abdomen; *ha*, halteres; *cx*, coxae; *sa*, subalar knob; *sp*, spiracle.

In most cases Rs is simple, but, when it is branched, Edwards has shown that the upper branch is in reality R_4 and not R_{2+3}; this branch, R_4, may take a vertical or transverse course and end in the costa or in R_1; in the latter case it forms a small submarginal cell which is a characteristic of the Sciophilinae, but its presence is sometimes inconstant even in a given species. The two forks which come after the radial sector will be referred to in my key and descriptions, for the sake of simplicity, as the *median fork* and the *posterior fork*. The former is formed by M_1 and M_2, whereas there has been some uncertainty as to the composition of the latter. Comstock and Needham and most authors consider it as formed by Cu_1 and Cu_2, but Tillyard has shown (Panorpoid Complex, Part 3, These Proc., 1919, 533) that the concave vein which runs below and right against the stem of this fork, and which is often interrupted, is in reality Cu_2, so that the posterior fork could be considered at most as a branched Cu_1, a state of affairs unknown in Diptera and even in the Mecoptera.

If the venation of the primitive genera like *Ditomyia* or *Bolitophila*, or even the less primitive *Nicholsonomyia*, in which the base of M is still present, be examined, it will be seen that the vein between M_2 and Cu_1 is actually M_{3+4}, and that the vein which unites it to Cu_1 is m-cu and not the base of Cu_1. In more specialized forms, where m-cu has disappeared, the posterior fork may seem to be a branched cubitus, but it is none the less formed by the switching over of M_3 on to Cu_1.

Cu_2 has even been taken by authors as one of the anal veins, but the true first anal vein is a convex one and cannot be confused with Cu_2 for this reason. It is often interrupted, weak, or even absent; in a few cases a trace of a second anal vein may be distinguished.

The wing membrane of the Mycetophilidae carries microscopic setae, known as microtrichia, which can be arranged in definite rows, but in many cases large hairs, the macrotrichia, are also present; they can easily be distinguished under low magnification with a pocket lens. These macrotrichia may completely take the place of the microtrichia, in which case they will be recognized not only by their size, but also by their more or less pronounced curvature.

Characters given by the presence or absence of bristles or hairs on some of the parts of the thorax are of great help in the classification of the family. Text-figure 1 explains the nomenclature of the different parts of the thorax.

Key to Subfamilies.

1. Medio-cubital cross-vein present (Plate xxii, figs. 1-5) 2
   Media and cubitus not connected by cross-vein, M_3 being in contact with Cu_1 and forming a fork with it (Pl. xxii, figs. 6-12; Pl. xxiii, figs. 13-22) 6
2. R_4 present and rather long, generally half or more than half as long as R_5; Sc short and ending free (Pl. xxii, fig. 1); posterior divisions of pronotum with one or more longish bristles ..... Ditomyiinae
   R_4 less than half as long as R_5, sometimes weak or absent; Sc almost always long and ending distinctly in the costa (Pl. xxii, figs. 4, 5); posterior divisions of pronotum without long bristles 3
3. Media and radius fused for a short distance (Pl. xxii, figs. 4, 5) 4
   These two veins not fused, a distinct r-m cross-vein being present (Pl. xxii, fig. 2) 5
4. M_3 and Cu_1 at first convergent, then divergent (Skuse, 1888*b*, Pl. xxxi, figs. 1-2), if not so the wing membrane carries macrotrichia or else the head has two longitudinal furrows; tibial bristles absent ..... Macrocerinae
   M_3 and Cu_1 divergent from the start (Skuse, 1888*b*, Pl. xxxi, fig. 3); macrotrichia always absent from the wing membrane; tibial bristles present even if small ..... Ceroplatinae
5. Media with distinct basal section (Pl. xxii, fig. 2) ..... Bolitophilinae
   Basal section of media absent 6
6. R_1 and Rs running separately to the base of the wing; traces of the base of R_{2+3} present (Skuse, 1890*b*, Pl. xix, fig. 1) ..... Lygistorrhininae
   R_5 rising from R well beyond the base of wing, or base of Rs wanting; no trace of R_{2+3} 7
7. Eyes nearly or quite connected above antennae by a dorsal bridge; if eyes rounded, then the male wingless or both sexes wingless; base of Rs short and transverse; r-m long and in a line with Rs ..... Sciarinae
   Eyes rounded without dorsal bridge; base of Rs and r-m usually more or less oblique except in many Sciophilinae 8
8. Prothorax without strong bristles but some bristles or hairs present on other parts of the thorax; head flat or slightly concave behind with a row of projecting orbital bristles which are more or less curved backwards; antennae inserted above the middle of the head (only one genus, *Manota*) ..... Manotinae
   Prothorax with distinct long bristles or no bristles at all on the thorax; head convex behind; orbital bristles not forming a conspicuous row; antennae inserted about the middle of the head 9

9. Microtrichia of wings irregularly arranged; Sc usually long; lateral ocelli usually far from the margins ..... Sciophilinae
Microtrichia of wings in more or less distinct lines; Sc short; lateral ocelli always touching the eye margins ..... Mycetophilinae

Key to the Genera.[1]

Subfamily DITOMYIINAE.

1. Cross-vein r-m present; antennae flattened; several bristles on posterior division of pronotum 2
Cross-vein obliterated by fusion; antennae cylindrical; one strong bristle on posterior divisions of pronotum; eyes deeply emarginate above antennae with narrow *Sciara*-like dorsal bridge ..... (*Nervijuncta* Marshall)
2. Basal section of Rs, r-m and basal section of M_3 all in a nearly vertical line so that the distal end of the basal cell is truncated (Pl. xxii, fig. 1) .. *Centrocnemis* Phil.
Basal cell pointed at its distal end, the basal section of Rs and M_1 being oblique in opposite directions 3
3. Eyes reniform; R_4 hardly longer than the second portion of Rs; anepisternites and postnotum bristly ..... (*Symmerus* Walker)
Eyes rounded; R_4 much longer than the second portion of Rs; anepisternites and postnotum bare ..... (*Ditomyia* Winn.)

Subfamily BOLITOPHILINAE.[2]

Only one genus ..... (*Bolitophila* Meig.)

Subfamily DIADOCIDIINAE.

Sc ending in costa; An reaching the wing margin; r-m and first section of M_2 in one transverse line (Pl. xxii, fig. 3) ..... *Diadocidia* Ruthe.
Sc ending free; An evanescent; r-m uniting Rs and M_1 not in contact with M_2 .....
..... (*Heterotricha* Lw.)

Subfamily MACROCERINAE.

Head with longitudinal furrows; antennae about as long as the body, sometimes longer
..... *Macrocera* Mg.
Head without longitudinal furrows; antennae about as long as the thorax; their segments fusiform ..... (*Paramacrocera* Edw.)

Subfamily CEROPLATINAE.

1. Antennae with 12 to 15 segments 2
Antennae with 16 segments 4
2. Antennae strongly pectinate, pleurotergites hairy ..... (*Plateroptylon* West.)
Antennae simple 3
3. Antennae with 14 segments ..... *Antriadophila* Sk.
Antennae with 15 segments ..... *Pseudoplatyura* Sk.
4. Prothorax large, not divided in the middle; hind tibiae with only one irregular apical comb; labella greatly elongate, slender and rigid; palpi reduced; R_4 ending in R_1 ..... (*Rhynchoplatyura* de Meij.)
Prothorax small, usually divided in the middle or with only a narrow bridge uniting the two lateral parts of the pronotum; hind tibiae with both inner and outer comb 5
5. Mouth parts elongate, at least as long as the head; postnotum and pleurotergites bare; R_4 ending in the costa 6
Mouth parts not elongate 8
6. Labella greatly elongate and fleshy ..... (*Asyndulum* Latr.)
Labella small, but mouth parts produced either by elongation of the clypeus or of the labium 7

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[1] The genera placed in parentheses have not been recorded from Australia yet.

[2] *Arachnocampa* which was previously included among the Bolitophilinae, but whose connection with that subfamily was rather dubious, mostly on account of the larval morphology, has been recently removed by Edwards to the Ceroplatinae.

7. Sc_2 incomplete; labium elongate; palpi reduced and placed at the base of the proboscis ..... (*Antlemon* Hal.)
   Sc_2 complete, ending in costa; clypeus elongate; the palpi 4-segmented and inserted towards the middle of the proboscis ..... *Neoantlemon*, nov.
8. Palpi reduced with one swollen terminal segment and sometimes a small indistinct one; antennae usually stout and strongly compressed ..... *Ceroplatus*[1] Bosc.
   Palpi normal, with 3 or 4 distinct segments 9
9. Base of media quite distinct or indicated by a fold-like basal extension 10
   Base of media quite indistinguishable ..... *Platyura*[2] Meig.
10. Base of media distinct, no fusion between Rs and M ..... *Arachnocampa* Edw.
    Base of media fold-like (Pl. xxii, fig. 5), Rs and M partly fused 11
11. R_4 ending in R_1; 3 ocelli; pleurotergites and prosternum bare .... (*Apemon* Joh.)
    R_4 ending in costa 12
12. No ocelli ..... (*Hesperodes* Coq.)
    Three ocelli 13
13. r-m present ..... (*Paleoplatyura* Meun.)
    r-m absent, wasp-like fly (Text-fig. 2) ..... *Nicholsonomyia*, nov.

Subfamily Sciarinae.

(Key to Australian and New Zealand genera only.)

1. Palpi well developed; both sexes winged 2
   Palpi reduced with one or two small segments; female or both sexes sometimes wingless 5
2. Branches of media wide apart at the base beyond the middle; segments of male flagellum with long pubescence and long necks ..... *Zygoneura* Mg.
   Branches of median fork normal, parallel or widely divergent 3
3. The whole wing membrane rather densely covered with macrotrichia as well as all the veins ..... *Trichosia* Winn.
   Macrotrichia absent from the wing membrane 4
4. Costa produced over the tip of Rs ..... *Sciara* Mg.
   Costa not produced ..... (*Ohahunea* Edw.)
5. Both sexes winged, posterior fork past the proximal end of r-m ..... (*Scythroprochroa* End.)
   Female wingless or practically so, and sometimes halterless 6
6. Female antennal segments longer than broad and with necks; tergal and sternal plates of abdomen distinct; male winged ..... (*Phnyxia* Joh.)
   Female antennal segments not longer than broad 7
7. Female with very tiny rudiments of wings and with distinct halteres; mesonotum, scutellum and postnotum all well distinct from each other ..... *Austrosciara* Schmitz and Mjöberg
   Female without traces of wing or halteres; all the thoracic sclerites, except the pronotal side lobes, fused into one segment ..... (*Neophnyxia* Tonn.)

Subfamily Sciophilinae.

1. Two ocelli placed together; hind tibial microscopic setae arranged in regular longitudinal rows; wings without macrotrichia on the membrane ..... (Tribe Mycomyiini) 2
   Three ocelli or, when only two present, the hind tibial setae are irregularly arranged 3
2. Costa ending rather abruptly at the tip of R_5, which usually reaches the extreme tip of the wing; wings without conspicuous markings; no fold between R_5 and M_{1+2} (Skuse, 1890*b*, Pl. xix, fig. 3); eyes slightly emarginate above antennae ..... *Mycomyia* Rond.
   Costa usually continued at least a short distance beyond the tip of R_5, which does not quite reach the wing-tip; wings usually with conspicuous markings; usually a more or less distinct, often vein-like fold between R_5 and M_{1+2}; eyes not or scarcely emarginate ..... *Neoempheria* O.-S.

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[1] For key to subgenera of *Ceroplatus*, including *Heteropternus*, see Edwards, These Proceedings, 1929, 173.

[2] For key to subgenera of *Platyura*, see These Proceedings, 1929, 163.

3. Wing with macrotrichia on the membrane; the macrotrichia sometimes absent; postnotum usually with hairs or bristles; Sc nearly always long; last section of R_1 several times as long as r-m which is usually oblique; 7th abdominal segment usually large and visible ..... (Tribe Sciophilini) 5
Wings without macrotrichia on the membrane; 7th abdominal segment usually small and retracted 4

4. Sc always long; last section of R_1 several times as long as r-m which is more or less oblique or transverse; median fork always much longer than its stem ..... (Tribe Gnoristini) 32
Sc long or short; last section and R_1 usually little if not longer than r-m which is long and nearly longitudinal (Pl. xxiii, fig. 19) ..... (Tribe Leiini) 42

5. Lateral ocelli contiguous with the eye margins 6
Lateral ocelli remote from the eye margins 7

6. Abdomen normal, as in *Platyura* ..... (*Eudicrana* Lw.)
Abdomen cylindrical, elongate, about three times as long as the thorax (Pl. xxii, fig. 6) ..... *Pareudicrana*, nov.

7. Base of the posterior fork distinctly proximal to that of the media; hind tibiae without distinct apical comb 8
Base of posterior fork distinctly distal, or nearly under that of the media, or else either that fork or that of the media absent; hind tibiae generally with a distinct apical comb; pronotum hairy 17

8. Postnotum hairy or bristly, at least towards its side; pleurotergites hairy 9
Postnotum quite bare 15

9. M_1 complete or almost so 10
M_1 faint or obviously defective at base; R_3 rather wavy; Sc_2 before the middle of Sc, sometimes faint or absent; wings unmarked 14

10. Sc_1 interrupted, ending free ..... (*Taxicnemis* Edw.)
Sc_1 complete 11

11. Sc_2 well beyond the middle of Sc_1 13
Sc_2 before the middle of Sc_1 or else absent 12

12. Micro- and macrotrichia both present on the wing membrane; Sc_2 absent (Pl. xxii, fig. 8) ..... *Neoallocotocera*, nov.
Only the macrotrichia present on wing membrane; Sc_2 present (Pl. xxii, fig. 7) ..... *Allocotocera* Mik.

13. R_5 straight; costa not produced beyond tip of R_5; wings with dark markings .... (*Leptomorphus* Curt.)
R_5 wavy; costa distinctly produced; wings unmarked ..... (*Polylepta* Winn.)

14. Costa produced but slightly over R_5 ..... (*Neuraltelia* Rond.)
Costa produced much beyond the tip of R_5; base of M_1 traceable, but faint, and placed only slightly beyond the posterior fork ..... (*Paraneuroltelia* Landr.)

15. Pleurosternites hairy; Sc ending in R_1; body stout ..... (*Syntemna* Winn.)
Pleurosternites bare; Sc ending in the costa; body usually long and slender 16

16. Macrotrichia present at tip of wing only; Sc_2 in the middle of Sc_1 .... (*Paratinia* Mik.)
Macrotrichia present over the whole wing; Sc_2 well before the middle of Sc_1 (Pl. xxii, fig. 10) ..... *Aneura* Marsh.

17. Posterior fork under or just a little before the median fork (Pl. xxii, fig. 9) .... *Tasmanina*, nov.
Posterior fork, when present, well after the median one 18

18. Legs extremely long and slender; the first segment of front tarsi twice as long as the tibia; median fork broad, the branches curving widely apart at the base; Cu wavy at the end (Pl. xxii, fig. 11) ..... *Phthinia* Winn.
Legs normal; median fork pointed at base or absent 19

19. M_2 complete 20
M_2 detached, present only as a short, free vein on the wing margin; M_3 also faint or detached at the base 28

20. Stem of median fork more than twice as long as r-m; anepisternites and subalar knob hairy; no posterior fork ..... (*Parvicellula* Marsh.)
Stem of median fork very short, at most twice as long as r-m 21

21. The posterior fork present although sometimes incomplete 22
No posterior fork 27
22. Posterior fork incomplete; the base of M_3 obsolete ..... (*Morganiella* Tonn.)
Posterior fork complete 23
23. Sc_2 beyond base of Rs 24
Sc_2 before or over the base of Rs 25
24. Mouth parts elongate (at least in the male) (Text-fig. 5); macrotrichia recumbent, pointing towards the tip of wing (Pl. xxiii, fig. 15) .... *Paramorganiella*, nov.
Mouth parts normal; macrotrichia erect or pointing slightly towards base of wing ..... (*Megalopelma* End.)
25. Sc_2 ending just a little over the base of Rs; posterior fork very short; last section of Cu_1 bent so as to end perpendicularly to the wing margin (Skuse, 1890*b*, Pl. xix, fig. 5) ..... *Stenophragma* Skuse.
Sc_2 ending well after the base of Rs; posterior fork usually long, its branches normal 26
26. Anepisternites hairy ..... (*Sciophila* Mg.)
Anepisternites bare ..... Subgen. *Austrosciophila*, nov.
27. Macrotrichia recumbent as in *Sciophila* ..... *Acnemia* Winn.
Macrotrichia reflexed as in *Megalopelma* ..... (*Monoclona* Mik.)
28. Sc short, not reaching the costa or R_1, ending free ..... (*Azana* Walk.)
Sc reaching the costa 29
29. Anepisternites and subalar knob hairy 30
Anepisternites and subalar knob bare 31
30. Sc ending in costa; r-m oblique and short (Skuse, 1888*b*, Pl. xxxii, fig. 12) ..... *Trizygia* Skuse.
Sc ending in R_1; r-m longitudinal and elongate ..... (*Neotrizygia* Tonn.)
31. M_1 complete (Pl. xxiii, fig. 14) ..... *Paratrizygia*, nov.
M_1 incomplete; fork highly arched; slender insect (Skuse, 1888*b*, Pl. xxxii, fig. 13) ..... *Aphlelomera* Skuse.
32. Seventh abdominal segment quite large in both sexes and even the eighth visible externally; very slender insect ..... (*Spioletta* Edw.)
Seventh abdominal segment usually retracted, but when visible then noticeably smaller than the preceding one, the eighth not visible 33
33. Thorax completely devoid of hairs or bristles; only one tibial spur present (Pl. xxiii, fig. 18) ..... *Pseudalysiinia*, nov.
Thorax with some hairs or bristles 34
34. Base of posterior fork well beyond that of the media ..... (*Coelosia* Winn.)
Base of cubital fork before, below or scarcely beyond that of the media 35
35. Sc ending free (Pl. xxiii, fig. 17) ..... *Austrosynapha*, nov.
Sc ending in costa or in R_1 36
36. Sc ending in R_1 37
Sc ending in the costa 38
37. Proboscis slightly produced, about as long as the head ..... (*Hadroneura* Lund.)
Proboscis not at all produced ..... (*Dziedzickia* Joh.)
38. Proboscis very elongate ..... (*Gnoriste* Mg.)
Proboscis shorter than the head 39
39. Sc_2 present and placed well beyond middle of Sc_1 40
Sc_2 near middle of Sc_1 or absent 41
40. Base of posterior fork beyond base of stem of median fork (Pl. xxiii, fig. 16) .... *Synapha* Mg.
Base of posterior fork below or before base or stem of median fork ..... (*Palaeoempalia* Meun.)
41. R_4 present; Sc_2 absent ..... (*Apolephthisa* Grzeg.)
R_4 absent; Sc_2 usually present ..... (*Boletina* Staeg.)
42. Sc distinctly ending in the costa (faint apically in some species of *Leia*); tibial bristles long and strong 43
Sc usually short, ending free or in R_1 50
43. R_1 twice as long as r-m which is rather oblique; M_1 often detached at base; Sc_2 absent ..... (*Rondaniella* Joh.)
R_1 at most twice as long as r-m, often shorter; r-m usually longitudinal 44

44. Lateral ocelli far removed from eye margins 45
Lateral ocelli touching the eye margins, or else less distant from them than their own diameter 47
45. M_3 and M_1 both distinct at base ..... (*Grcenomyia* Brunn.)
M_3 detached at base 46
46. M_1 detached at base (Skuse, 1888*b*, Pl. xxxii, fig. 11) ..... *Atelia* Skuse.
M_1 not detached at base ..... (*Cawthronia* Tonn.)
47. Base of Rs wanting; M_1 and M_3 detached at base ..... (*Leiella* End.)
Base of Rs present; M_1 not detached at base 48
48. Pleurotergites not bulging and devoid of hairs ..... *Paraleia*, nov.
Pleurotergites bulging and hairy 49
49. Costa ending at tip of R_5 and M_3 complete at base ..... *Leia* Mg.
Costa produced over the tip of R_5, if not so, then M_3 is incomplete at base; Sc_2 present or absent; anal vein strong or faint (Skuse, 1888*b*, Pl. xxxii, fig. 10) ..... *Acrodicrania* Skuse
50. M_3 detached at base 51
M_3 not detached at base 54
51. M_{1+2} simple; ocelli touching the eye margins 52
M_{1+2} forked; ocelli remote from the eye margins 53
52. Cu_1 sinuous; An. ending in its elbow or else ending free at some distance before this elbow; the little cell not being thus completely closed ..... (*Cycloneura* Marsh.)
Cu_1 nearly straight, not forming a small cell with An. .... (*Paracycloneura* Tonn.)
53. Costa not produced over the tip of R_5 (Skuse, 1890*b*, Pl. xix, fig. 6) ..... *Clastobasis* Skuse.
Costa produced over the tip of R_5 ..... (*Paradoxa* Marsh.)
54. Ocelli wanting; a chitinized fold between R_5 and M_1 ..... (*Syndocosia* Speiser.)
Ocelli present, no fold between R_5 and M_1 55
55. R_1 very short; r-m several times longer than R_1; lateral ocelli not very far distant from the eye margins ..... (*Novakia* Strobl.)
R_1 not shorter than r-m, sometimes 2, 3 or more times longer 56
56. Lateral ocelli touching the eye margins ..... (*Docosia* Winn.)
Lateral ocelli remote from the eye margins 57
57. Sc ending in R_1; posterior fork near the base of wing .... (*Ectrepesthoneura* End.)
Sc short and ending free; posterior fork more distal 58
58. Cu_1 sinuous; An. ending in one of its elbows; M_1 sinuous ..... (*Sigmolea* Edw.)
Cu_1 straight; An. not fusing with it 59
59. Hind tibial comb present ..... (*Megophthalmidia* Dz.)
Hind tibial comb absent 60
60. Pleurotergites hairy ..... (*Trichoterga* Tonn.)
Pleurotergites bare (Pl. xxiii, fig. 13) ..... *Tetragoneura* Winn.

Subfamily MYCETOPHILINAE.

1. Anepisternal and pteropleural bristles absent; hind coxa with a fairly strong bristle at base; empodia absent or rudimentary; hind tibial comb usually indefinite or absent; tibial bristles short ..... (Tribe *Exechini*) 2
Anepisternal bristles present; hind coxa usually without basal bristle; empodia and hind tibial comb nearly always distinct ..... (Tribe *Mycetophilini*) 6
2. Costa produced well beyond tip of R_5 ..... (*Anatelia* Winn.)
Costa ending at R_5 3
3. Base of posterior fork beyond that of the media (Skuse, 1890*b*, Pl. xix, fig. 9) .... *Exechia* Winn.
Base of posterior fork below or before that of the media 4
4. An. strong and distinct (Pl. xxiii, fig. 20) ..... *Rhymosia* Winn.
An. short and weak or absent 5
5. Cu_2 very long and distinct, reaching nearly to the middle of the posterior fork .... (*Brachypeza* Winn.)
This vein shorter and less distinct (Pl. xxiii, fig. 21) ..... *Allodia* Winn.
6. Pteropleural bristles absent 7
Pteropleural bristles present; tibial bristles long and strong 10
7. Tibial bristles long and strong; Sc ending in R (Skuse, 1890*b*, Pl. xix, fig. 8) .... *Dynatosoma* Winn.
Tibial bristles small, at most a little longer than the diameter of the tibia 8

8. Second segment of palpi greatly enlarged ..... (*Cordyla* Winn.)
Second segment of palpi not enlarged 9
9. Base of posterior fork below or before that of the media; Sc rather long and normally ending in R ..... *Trichonta* Winn.
Base of posterior fork beyond that of the media, Sc ending free .. (*Phronia* Winn.)
10. A posterior fork present 11
No posterior fork 14
11. M_3 slightly divergent from M_2 apically, but parallel with or slightly convergent towards Cu_1; pleurotergites and pteropleurites generally quite large; costa ending at tip of R_5 (Skuse, 1888*b*, Pl. xxxii, fig. 15) ..... *Mycetophila* Mg.
M_3 parallel with M_2 throughout, but slightly divergent from Cu_1; pleurotergites and pteropleurites small; head usually fitting very closely into the front of the thorax 12
12. Pronotal lobes distinctly separated from the propleura, and provided with distinct long bristles; base of posterior fork hardly if at all before r-m; costa distinctly produced beyond tip of R_5 ..... (*Epicypta* Winn.)
Pronotal lobes only indistinctly separated from the propleura and without long bristles; base of posterior fork well before r-m 13
13. Costa produced beyond tip of R_5; second abdominal segment without ventral bristles ..... (*Platurocypta* End.)
Costa ending at tip of R_5; second abdominal segment with a pair of ventral bristles (Skuse, 1890*b*, Pl. xix, fig. 7) ..... *Delopsis* Skuse.
14. M_2 and M_3 slightly divergent; pleurotergites and pteropleurites large; middle tibiae without ventral bristles; R_1 and R_5 often rather closely approximated 15
15. Costa hardly produced beyond tip of R_5 ..... *Sceptonia* Winn.
Costa produced far beyond tip of R_5 ..... (*Platyprosthiogyne* End.)

Subfamily Ditomyiinae.

Genus Centrocnemis Phil.

This genus, which was sunk under *Symmerus* by Johansen, has been reinstated by Edwards to include the species of the neotropical and Australian regions. Two species have been described by Edwards from Tasmania, *C. fuscinervis* and *C. aculeata*. I know at least six other species from Tasmania and from Victoria, several of them being common to both States. Five species are known from New Zealand. The wing venation is given in Plate xxii, fig. 1.

Subfamily Diadocidiinae.

Genus Diadocidia.

This genus was so far known from Europe and North America only, where it is represented in each case by two species. It is represented in Tasmania by one species, which I found in very widely distant localities: Strahan, Hartz Mountains and National Park. It seems, therefore, to be widely distributed in that State, although not common. This species agrees in every detail of venation (see Pl. xxii, fig. 3) and other morphological features as given by authors; but the antennae which are given by them as being 17-segmented with the last one very small, are in reality 16-segmented, the last one ending in an apiculus carrying three small, curved setae, and which cannot be confused with an independent segment when the antennae are mounted on slides and examined under high power. The examination of the antennae was also made on the genotype *D. ferruginosa* Mg.

Subfamily Macrocerinae.

Genus Macrocera Mg.

For the venation see Skuse, 1888*b*, Plate xxxi, figs. 1 and 2. Only three species of this genus have been recorded by Skuse for New South Wales, two of which are also found in Tasmania. This genus is much better represented in New Zealand, where seventeen species have been found so far.

Subfamily CEROPLATINAE.

Genus NEOANTLEMON, nov.

Head somewhat flattened; eyes hairy, slightly emarginated above the base of antennae; ocelli three in a triangle, the middle one forward and noticeably smaller than the lateral ones, which are well distant from the eye margins. Antennae 2 + 14 segmented, noticeably longer, thicker and more flattened in the male; the flagellar segments somewhat longer than wide (in the male the antennae are nearly as long as the thorax, in the female only half as long). Mouth parts elongate, about as long as the head, the elongation being due to the extension of the clypeus; the palpi are therefore placed towards the end of the proboscis; palpi 4-segmented, the segments subequal. Pronotum well developed, not divided in the middle where there is a bridge which is also present, although not so evident, in many species of *Ceroplatus* and *Platyura*. Thorax of normal shape, the pleurotergites moderately swollen, bare, as well as the postnotum and the pleurae. Prothorax bristly. Mesonotum with small hairs on the disc, on which there are four bare vittae. Abdomen about twice as long as the thorax, with seven visible segments, flat in the male. Legs rather slender; tibiae with rows of inconspicuous small bristles; tibial spurs 1.2.2, the internal ones larger; posterior tibiae with internal and external apical combs. Claws toothed; empodium and pulvilli not distinct. Wings with microtrichia only, venation similar to that of *Platyura* (see Pl. xxii, fig. 4). All longitudinal veins reaching the wing margin, except sometimes the An vein which is somewhat undulated.

Genotype, *N. apicalis*, n. sp.

Another species occurs also in New South Wales (in Nicholson's collection). This genus is clearly distinguished from *Antlemon* by the characters given in the key to the genera. In some respects it comes near to *Rhynchoplatyura*, the pronotum not being actually divided in the middle, although not really much more developed than in certain species of *Ceroplatus*; besides, *Rhynchoplatyura* has no regular hind tibial combs and the labella are very elongated and thin.

NEOANTLEMON APICALIS, n. sp.

♂. Head with its appendages, thorax and abdomen completely black, little shining. Halteres orange; front coxae partly obscured, orange externally and distally; the others as dark as the body. Femora orange, the hind ones dark on their distal third; tibiae rather darker than the femora; tarsi brown, abdomen flat with subparallel sides, its pubescence, as well as that of the thorax, dark; hypopygium of the simple type, like that of *Platyura*. Wing as in Plate xxii, fig. 4; hyaline, the last apical fifth infuscated.

Length of wing, 4 mm.

♀. Similar to male, front coxae more extensively orange, hind femora not darker apically, abdomen fusiform, not flat. Posterior border of sternites obscure orange. End lamellae dark. Apical infuscation of wing darker.

Type.—Eaglehawk Neck, Tasman Peninsula, 23rd November, 1922 (Tonnoir). Allotype: Burnie, 26th October, 1922 (Tonnoir). Paratypes: Eaglehawk Neck, with the type; Cradle Valley, 23rd January, 1923; National Park, 16th December, 1922.

Genus ANTRIADOPHILA Skuse.

Four species of this genus have been described by Skuse. I have seen the paratypes of three of them, but in none of these are the mouth parts elongate.

The genus is therefore to be distinguished from *Pseudoplatyura* only by the number of antennal segments, contrary to what is given in Edwards' table (page 522). The genus is apparently not known outside Australia.

Genus Pseudoplatyura Skuse.

This genus was proposed for one species, *P. dux*, which differs only from the species of the preceding genus by an additional segment on the antennae. As so little difference exists between them, it is to be wondered if it would not be wiser to unite all these *Platyura*-like species with less than sixteen antennal segments, in one single genus. *Pseudoplatyura* would have priority. A species of *Pseudoplatyura* is also found in New Zealand. The genus seems so far to be restricted to the Australasian regions.

Genus Ceroplatus Bosc.

In his recent study of the subfamily Ceroplatinae (These Proc., 1929, 173) Edwards included *Cerotelion* Rond., *Heteropterna* Sk., and *Placoceriates* End. as subgenera of *Ceroplatus*. This procedure is evidently right for *Cerotelion* and perhaps for *Placoceriates*, but not so evident for *Heteropterna* Sk., of which I have seen several specimens in Skuse's collection. On account of the swollen hind legs and the rounded head with large eyes nearly touching on the face (at least in the males), these flies have the peculiar facies of small Bibionidae; the first antennal segment is normal, not in shape of a "benitier" as in *Ceroplatus*.

If one accepts Edwards' interpretation of the genus *Ceroplatus*, four Australian species can be referred to it: two belonging to his subgenus *Mallochinus* and two to *Heteropterna*; both subgenera are peculiar to Australia.

Genus Platyura Meig.

The known Australian species of this genus are comprised in seven of the nineteen subgenera recognized recently by Edwards as follows: *Isoneuromyia* Brun. (one species), *Pyrtaula* Edw. (three), *Rypatula* Edw. (one), *Neoplatyura* Mall. (four), *Xenoplatyura* Mall. (four), *Proceroplatus* Edw. (one), and *Lutarpya* Edw. (one).

The key to these subgenera and others is given by Edwards (These Proc., 1929, 163). The last one only is peculiar to Australia, but the second and third are found in Australia and New Zealand, whereas the others are more or less cosmopolitan. Four of the Australian species of *Platyura* are doubtfully referred to these subgenera; a study of Skuse's type is necessary before Edwards' allocation of *P. gracilis* Sk. to *Rypatula*, *P. monticola* Sk. to *Neoplatyura*, *P. contingens* Sk. to *Xenoplatyura* and *P. graphica* to *Proceroplatus* can be confirmed.

Genus Arachnocampa Edw.

This genus is common to Tasmania and New Zealand. The Tasmanian species, *A. tasmaniensis* Ferg., has, like the New Zealand one, a luminous larva living in caves. The morphology of this larva is very close to that of *Ceroplatus* larvae, some of which are also luminous in Australia. The wing venation is shown in Plate xxii, fig. 2.

Genus Nicholsonomyia, nov.

Head rounded; eyes hairy, round, with only a very slight emargination above the base of antennae. Clypeus slightly produced. Palpi 4-segmented, the first segment little distinct, the second dilated, the last two subequal. Antennae 2 + 14

segmented, rather thick, somewhat flattened, the segments of the flagellum about as wide as long; the whole antennae as long as the mesonotum. Ocelli three, equal in size, the median one placed more forward, all on a somewhat raised portion of the vertex. Pronotum well developed, not interrupted in the middle. Mesonotum highly arched, the scutellum very small and densely hairy. The postnotum moderately large, but produced so as to overhang the base of the abdomen up to about the middle of the first segment. The mesonotum, scutellum and postnotum form an uninterrupted curve when seen in profile. The different sclerites of the mesopleurae bare. The pleurotergites produced in the shape of a keel. Abdomen in female with seven visible segments and with a strong waist, the first and second segments being much narrower than the following ones; the segments subcylindrical so that the abdomen is very similar to that of *Polistes*; last segments gradually diminishing in size, the end of the abdomen being, therefore, pointed. End lamellae projecting. Legs rather long. End tibial spurs 1.2.2, the internal ones longer. Internal and external hind tibial combs present; tibiae and tarsi with fine setae arranged in definite straight rows, except at tip of tibiae which carry as well some rows of small bristles. Claws toothed. Empodium and pulvilli not distinct. Wing so large as to reach the tip of the abdomen when folded and characterized by the presence of a fold-like basal extension of M. All the rest of the venation (see Pl. xxii, fig. 5) similar to that of *Platyura*, all the veins reaching the wing margin. Concave folds are also present between R_1, Rs and M_1.

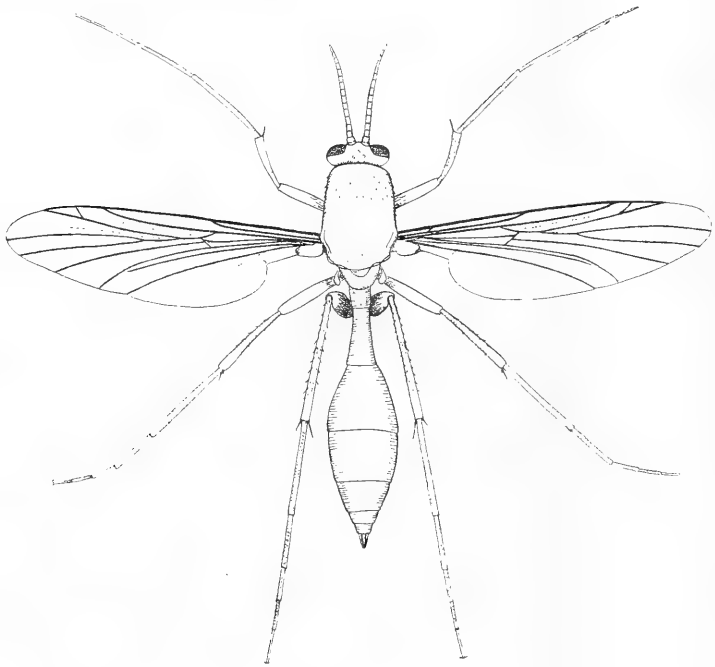
Genotype, *N. vespiformis*, n. sp.

This genus is characterized chiefly by the shape of the abdomen which has a strong waist and is otherwise shaped like that of *Polistes*, but this may be a sexual character, the male being still unknown and dimorphism in the shape of the abdomen is usual in the Ceroplatinae. The closest relationship of this new genus is with *Apemon* and *Platyura*, from which it differs, besides the characteristics given in the key, by the antennae more flattened, eyes not distinctly emarginated, palpi with second segment incrassate, propleurae strongly bristly, claws pectinate, empodium absent, abdomen pedunculate and rounded. The structure of the thorax is remarkable and quite different from that of *Apemon* (*Platyura marginata*), for instance, in which the arrangement of the head, thorax and abdomen is such that the insect appears humpy, like most Mycetophilidae, the head being scarcely visible from above. In *Nicholsonomyia*, on the contrary, the thorax is redressed in such a way that the head is quite visible from above and the postnotum overhangs the base of the abdomen. This conformation, which adds to the wasp-like appearance of the insect, is also found in some of the New Zealand forms of *Platyura*, like *P. harrisi* Tonn., *P. philpotti* Tonn., etc., but in these species the abdomen is quite flat in the females and there is no vein-like fold in the basal cell of the wing. The strongly projecting pleurotergites and postnotum, between which the halteres are lodged in a hollow, are common to these forms and to *Nicholsonomyia*.

Nicholsonomyia vespiformis, n. sp.

♀ (Text-fig. 2). General coloration brown, more ferruginous in parts and with some yellow markings. Head: Vertex brown; occiput ferruginous; face yellow; antennae and palpi orange; labellum brown. Mesonotum ferruginous-brown with three darker rather indistinct vittae. Pleurae blackish-brown; also the coxae which are yellowish towards the tip. Legs brown, knees and tip of tibiae as well as base of tarsi yellowish. Abdomen ferruginous-brown. Base of tergites

1, 2 and 3 yellow, that of segment 2 more extensively; sternites 1 and 2 completely yellow; tergites and sternites 4 to 7 with narrow yellow posterior border. End lamellae yellowish. Halteres yellowish, the knob mostly brown. Wings (Pl. xxii, fig. 5) noticeably infuscated, the tip being darker and the anterior border yellowish; vein yellowish-orange. Pubescence of the metathorax yellowish, short and adpressed. No bristles, except a small tuft above the wing base, also a more dense tuft on the propleurae. Scutellum completely covered with a dense adpressed pubescence; that of the abdomen also adpressed and more or less light brown, darker and denser on tergite 1.



Text-fig. 2.—*Nicholsonomyia vespiformis*, n. sp.; female.

Wing length, 9 mm. Body, 11·5 mm. (without antennae). This is one of the largest Mycetophilids, with some species of *Nervijuncta*.

Holotype: Port Macquarie, 19th April, 1924, A. J. Nicholson. In Sydney University collection.[1]

Subfamily Lygistorrhininae.

Lygistorrhina Skuse.

This genus was erected by Skuse for a single species from New South Wales, *L. insignis*. Since then the genus has been recorded, according to Edwards, from South America, West Indies, Africa, Ceylon, and Borneo. The typical wing venation (see Skuse, 1890*b*, Plate xix, fig. 1) and the exceedingly elongate mouth parts give to these forms a special rank among the Mycetophilidae.

[1] The account of the peculiar circumstance of the capture of this remarkable insect has been given by Dr. Nicholson in *The Australian Zoologist*, Vol. 5, 1927, 58.

Subfamily Sciarinae.

Sixty species of *Sciara* have been described with much care by Skuse. However, a revision of his types and a careful study of their genitalia should be made before any accuracy could be reached in the determination of the numerous species which are found everywhere in Australia. Besides, a certain number of species described by him as new are certainly introduced ones. This may be true also of the only recorded species of the genera *Trichosia* and *Zygoneura*. The only species of *Austrosciara*, *A. termitophila*, is an inquiline in termites' nest.

Subfamily Manotinae.

Genus Manota Skuse.

This genus is represented in New Zealand and is known from many other parts of the world, South America, West Indies, Seychelles, Ceylon and Europe. It will very likely also be found in Australia sooner or later.

Subfamily Sciophilinae.

Genus Mycomyia Rd.

Four species have been described by Skuse under the generic name of *Sciophila*. The wing venation is figured by him (1890*b*, Plate xix, fig. 3). This genus is very well represented in Tasmania, where I have found about fourteen species, some of which, however, may be identical with some of those already described from the mainland. Only three species are known from New Zealand.

Genus Neoempheria Skuse.

One species only has been recorded and described by Skuse from New South Wales. The wing venation characterized by the fold between Rs and M_1 is depicted by Skuse (1890*b*, Plate xix, fig. 4). The genus is known also from Europe, United States of America, East Indies, West Indies and South America. Edwards mentions that it is better developed in the tropics than in the temperate regions. It has not yet been found in New Zealand.

Genus Pareudicrana, nov.

Head relatively small; eyes hairy and perfectly round; only the lateral ocelli present and touching the eye margins; face produced; palpi 4-segmented, rather long; antennae filiform, 2 + 14 segmented. Scape and pedicel cyathiform. Segments of the flagellum cylindrical, three to five times as long as wide, the antennae being, therefore, fairly thin, about twice as long as the head and thorax in the male, and shorter in the female. Thorax highly arched. Mesonotum with long bristles, chiefly on the sides, as well as the normal pubescence. Propleurae bristly. Anepisternites bare. Pleurotergites and postnotum bristly, the former rather bulging. Abdomen long and thin in both sexes, about four times as long as the thorax; cylindrical in the male, gradually but slightly thicker distally in the female. Seven segments are visible in the female and eight in the male. Hypopygium of the simple pincers type. Legs slender. Tibiae with three to four rows of small bristles about equal to the diameter of the tibiae. Small setae irregularly arranged. Tibial spurs 1.2.2, of equal size. Only hind internal comb present. Claws, especially the hind ones, distinctly pectinate at the base. Empodium very small. Wings not quite as long as the abdomen; microtrichia and macrotrichia present on the membrane; the latter more sparsely distributed towards the

base of the wing. Venation as shown in Plate xxii, figure 6. Cell R_1 more or less elongate. Posterior fork distinctly proximad to the median one or nearly under it. Costa produced over the tip of R_5.

Genotype, *P. monticola*, n. sp.

The two Australian species agree quite closely with *Eudicrana*, a monobasic genus from North America, in having only two ocelli which are in contact with the eye margins and in having an almost identical venation. However, in spite of Loew and Johansen's good description, some rather important points have been left out, such as the eyes and antennal structures and also the general habitus but for the mention by Loew, that the body is similar to that of *Platyura*. The slender habitus of the two Australian forms which is similar to that of *Leptomorphus* on account of the long cylindrical abdomen, leads me to believe that the relationship between the Australian species and the American one might not be as close as the description of the latter seems to suggest. Indeed, the fact that Loew, who had a female before him when erecting the genus *Eudicrana*, compares the body to that of *Platyura*, seems to imply that *E. obumbrata* is not a specially slender insect and that its abdomen is flat as in most females of *Platyura*. I feel, therefore, justified in erecting the new genus for the two Australian species.

Pareudicrana monticola, n. sp.

♂. Head brown, clypeus paler; proboscis and palpi as well as base of antennae orange. Flagellum brown. Disc of mesonotum greyish-black, its margins and scutellum testaceous. Pleurae brown, somewhat more shining than the mesonotum. Postnotum paler above. Dark bristles on prothorax and round the mesonotum, none on the disc where the pubescence is yellowish. Bristles of pleurotergites and postnotum yellowish. Coxae yellowish with infuscated apex, on mid and hind pairs; all trochanters brown, as well as base of hind femora which is yellowish as well as the tip, the latter dark at apex, tarsi brownish, median tarsi very long, the first segment one and a half times as long as the tip. Halteres with yellow stem and black knob. Abdomen shining, dark brown, except the base of segments 3 to 4 and hypopygium. Abdominal pubescence pale. Wing venation as in Plate xxii, fig. 6. The large brown fascia on the small cell extending on the median fork and the apex extensively brown.

Length of body, 7 mm.; wing, $5\frac{1}{2}$ mm.

♀. On the whole the coloration is paler than in the male. The face is dark orange. The mesonotum shows three indistinct, very wide and confluent dark vittae. Basal half of abdominal segments, except the first and last, yellowish orange. Lamellae dark orange.

Length of body, 8 mm.; wing, 6 mm.

Holotype: Hartz Mountain, Tasmania, 9th December, 1922 (Tonn.). Allotype: With the type.

Pareudicrana nicholsoni, n. sp.

♀. Head testaceous, brown only on the vertex, round the two ocelli; mouth parts yellowish, as well as the base of the antennae; flagellum, except the base of the first segment, brown. Mesonotum mostly testaceous anteriorly with three dark median vittae which fuse at the back where the notum is mostly brown; on each side there is a post-humeral roundish brown spot. Scutellum brown, except at base. Postnotum and sides of thorax of a dirty testaceous brown coloration. The bristles of the thorax are more numerous than in the preceding species;

they are present not only on the side margins of the mesonotum, but on its anterior border and along the three dark lines. Bristles on postnotum and pleurotergites black. Abdomen dark brown. Base of segments three to six yellowish-orange; venter more extensively pale, end lamellae dark orange. Halteres yellowish. Legs yellowish. Sides of coxae and base of posterior femora somewhat infuscated. Tarsi dark.

Wing: Sc_2 placed above base of Rs, cell R shorter than one-third of the wing length; R_4 present closing the little marginal cell and placed at the level of the tip of Sc_1; section of M from r-m to the median fork about twice as long as r-m; posterior fork under the origin of Rs and consequently distinctly more proximad than the median fork; wing membrane hyaline on the basal half, evidently, but not strongly infuscated on apical half.

Length of body, $7\frac{1}{2}$ mm.; wing, 6 mm.

Holotype: Sydney, 10th July, 1923 (A. J. Nicholson).

Genus Allocotocera Mik.

This genus, formerly recorded from Europe and North America, has recently been found to be rather well represented in New Zealand, where four species have already been discovered. Three species collected by me in Tasmania agree well with the New Zealand forms and must be referred to this genus. The wing venation is given on Plate xxii, fig. 7 .

Genus Neoallocotocera, nov.

Head rather flattened dorsoventrally; eyes hairy, emarginated above the base of antennae; three ocelli in a line, median one smaller, the lateral ones far from the eye-margins. Clypeus somewhat produced. Palpi small, 4-segmented, the first segment scarcely distinct, the others subequal to each other. Antennae somewhat flattened, 2 + 14 segmented, not quite as long as the thorax. Segment of flagellum wider than long. Thorax not highly arched. Postnotum rather elongate. Anepisternites, pleurotergites and postnotum hairy or bristly. Subalar knob bare. Abdomen moderately slender, a little longer than the thorax. Seventh segment visible. Legs rather short. Tibial spurs 1.2.2, of nearly equal size. Mid and hind tibiae with two rows of small bristles, internal hind tibial comb present. Wings with both micro- and macrotrichia present; Sc long; Sc_2 absent; base of Rs perpendicular on R_1; r-m small, sublongitudinal; stem of median fork rather short; posterior fork placed nearly under the former; An. interrupted, M_3 not always connected with Cu_1 (see Pl. xxii, fig. 8).

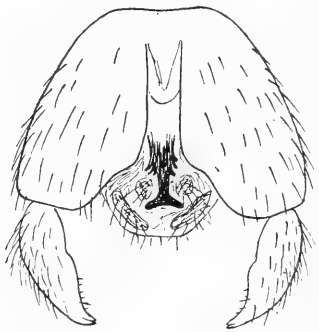
Genotype, *N. fusca*, n. sp.

This genus is closely related to *Allocotocera*, from which it differs mainly by the presence of both micro- and macrotrichia, the absence of Sc_2, the subalar knob bare, and the head structure which is more elongate, the lateral ocelli being, however, much more remote from the eye-margins. By its venation this genus comes near *Synapha*, from which it differs, among others, by the macrotrichia present on the wing membrane and the bristles on the side of the thorax.

Neoallocotocera fusca, n. sp.

♂. Head, thorax and abdomen black; rather shining; clypeus, mouth parts and base of antennae brown; hairs of the mesonotum irregularly arranged and completely blackish, as well as that on the other parts of the body. Halteres ferruginous, base of the knob darker, the knob as long as the stem. Coxae and

femora blackish; tibiae dark, ferruginous, as well as the base of the tarsi; the whole front pair including the coxae ferruginous. Tibial spurs orange. Wings slightly infuscated, somewhat more extensively on the anterior border; venation as on Plate xxii, fig. 8; macrotrichia not quite as dense towards the base of the wing; hypopygium as in Text-figure 3. Forceps with two blunt teeth at apex.



Text-fig. 3.—Hypopygium of *Neoallocotocera fusca*, n. sp.

Length of body, 2 mm.; wing, 2 mm.

Holotype: Cradle Valley, Tasmania, 12th January, 1923 (Tonn.).

Another much damaged specimen from Sassafras, Victoria, may belong to the same species, although M_3 is more or less detached at the base, but more so on the one wing than on the other.

Genus Aneura Marshall.

This genus was recorded only from New Zealand, where eleven species had been found. One species collected by me in Tasmania belongs indubitably to the genus; it is very closely related to *A. fusca* Tonn. In this species R_4 is present and Sc_2 also, but it is faint and placed near the base of S_2. The median fork is strong and both micro- and macrotrichia are present. Wing venation as on Plate xxii, fig. 10.

Genus Tasmanina, nov.

Head somewhat flattened dorsoventrally, nearly as wide as long; eyes scarcely distinctly pubescent, emarginated above base of antennae; ocelli 3, the median one smaller and placed only a little more forward; distance from the eye-margins to the lateral ocelli greater than the diameter of the latter; face little produced, hairy. Palpi moderately long, 4-segmented, the first very short, the last twice as long as or longer than the others. Antennae longer than the thorax (in the male), 2 + 14 segmented. Segments of the flagellum cylindrical, half to four times as long as wide. Thorax highly arched, the postnotum being half as long as the mesonotum. Pleurotergites bulging and hairy, as well as the postnotum and hypopleurites, but the anepisternites bare. Abdomen slender, cylindrical and elongate, about two to three times as long as the thorax; seventh or even eighth segment visible in the male. Legs elongate, but not specially slender. Fore tibiae longer than metatarsi; tibial spurs 1.2.2, the internal ones a little longer; hind internal apical tibial comb present, the external ones represented

by only three setae; tibial bristles small, not longer than the diameter of the tibiae, arranged in four rows on mid and hind tibiae. Claws dentated. Empodium distinct. Wings as on Plate xxii, fig. 9; Sc_2 near origin of Rs; base of that vein perpendicular, but r-m longitudinal and about equal to the stem of the median fork; posterior fork a little more proximad; An. interrupted; both micro- and macrotrichia present. Costa produced over the tip of Rs.

Genotype, *Tasmanina gracilis*, n. sp.

This genus is a link between the group *Leptomorphus* and the group *Sciophila*, as it has the hind tibial apical combs and the fork of Cu is proximal. The general habitus is that of *Leptomorphus*, but the venation is very different, in fact, it is nearly identical with that of *Boletina* from which, however, all other morphological features separate it very widely. The venation has also some similarity with that of *Morganiella*, but here the posterior fork is complete and the microtrichia are present. The venation differs from that of *Leptomorphus* by the sublongitudinal position of r-m, the costa reaching over the tip of Rs, and the two forks being at the same level; micro- and macrotrichia are both present. It shows relationship with the group *Sciophila* by the presence of the hind tibial combs and the chaetotaxy of the body, but the venation does not agree with any genus of that group in which the posterior fork is present; in that respect it comes nearer to *Morganiella*, as explained above, but in that genus the microtrichia are absent and its thickset habitus is strikingly different. In *Morganiella* M_3 is not complete at the base and the anepisternites are hairy.

Tasmanina gracilis, n. sp.

♂. Head, thorax and abdomen black, rather shining; mouth parts of a dirty yellow coloration; antennae dark brown, base of flagellum reddish; humeri ferruginous. Pleurae slightly grey-dusted, pubescence and bristles of thorax and abdomen pale. Eighth abdominal segment visible. Hypopygium dark, of the simple forceps type. Halteres yellow, legs with coxae blackish; the front pair paler distally. Femora and tibiae yellowish-brown; mid and hind tibiae darker at base and on apical third, more extensively so on the hind pair; tarsi gradually darker brown towards the tip. Bristles of tibiae smaller than the tibial diameter. Antennae twice as long as the thorax. The segments of the flagellum two to four times as long as wide. Wings very slightly and uniformly infuscated; venation as on Pl. xxii, fig. 9. Abdomen three times as long as the thorax.

Length of body, 5 mm.; wing, 4 mm.

Holotype: Mt. Wellington, Hobart, 18th November, 1922 (Tonn.).

Another species from Zeehan differs by comparatively shorter antennae and abdomen, and some details of venation.

Genus Phthinia Winn.

One species of this genus characterized by the extreme slenderness of the legs and abdomen has been found near Hobart. It agrees perfectly well with the European and New Zealand species; its venation is almost identical with that of the latter and it is depicted on Plate xxii, fig. 11.

Genus Stenophragma Skuse.

Skuse described three species of this purely Australian genus. I know two others, one from Tasmania, which is very closely related to *S. meridionalis* Skuse, and another from Victoria. In this genus the macrotrichia are well

developed on the base of the wing, as well as on its distal parts, contrary to what is given in Edwards' key to the genera. One would, however, be tempted to fuse this genus with *Sciophila*, but here Sc is not quite as long, scarcely reaching over the base of Rs, whereas the posterior fork is short, and the last section of Cu_1 is bent so as to end perpendicularly on the wing margin. The anepisternites are bare, the body and the legs are more slender and wings have usually a conspicuous dark pattern. The wing venation is given by Skuse (1888*b*. Plate xxxi, fig. 9).

Genus Sciophila Winn.

Subgenus Austrosciophila, nov.

A species which I collected in Tasmania could be included in *Sciophila*, with which it corresponds quite well, with the exception of the anepisternites which are bare. As this character seems to have more than a specific importance in the Sciophilinae, I propose to erect a subgenus, *Austrosciophila*, to receive it. The other characters which agree closely with those of *Sciophila* are as follows:

Head roundish, as high as wide; eyes hairy, emarginated above antennae; ocelli three, the middle one smaller and placed a little more forward, the lateral ones distant from the eye-margins about half their own diameter. Antennae as long as the thorax, 2 + 14 segmented. Segments of flagellum two to three times as long as wide. Palpi 4-segmented, the first shorter, the last distinctly longer than the others. Thorax well arched. Sternopleurae, anepisternites and subalar knob bare. Pleurotergites and postnotum bristly. Hypopleurites with one or two bristles. Bristly pubescence of mesonotum irregularly arranged. Abdomen about twice as long as the thorax, with seven visible segments. Legs moderately long. Front metatarsi subequal to tibiae. End tibial spurs 1.2.2, of equal length; claws dentated; empodium distinct; tibial bristles small, arranged in four rows and only hind internal tibial apical combs present, but little distinct. Wing venation as shown on Plate xxii, fig. 12. Only the microtrichia present on the wing membrane.

Subgenotype, *A. solitaria*.

Austrosciophila solitaria, n. sp.

♀. Head and mesonotum dull blackish-grey; clypeus, mouth parts, scape and pedicels blackish. Base of first flagellar segment yellowish, the rest dark brown. Sides of thorax and postnotum brownish and a little more shining than the notum, although quite distinctly grey-dusted. Abdomen shining blackish-brown; all bristles and pubescence of the body yellowish. Halteres yellow. Apex of antennae dark. Legs, including coxae, yellow, tarsi darker. Wings hyaline; venation as on Plate xxii, fig. 12.

Holotype: Mount Field, National Park, 21st December, 1922 (Tonn.).

Genus Trizygia Skuse.

This genus, erected by Skuse for a single species, remains so far typically Australian. However, a very closely allied one has been recently found in New Zealand. Besides the genotype, *T. dux*, another species occurs in New South Wales which I found in Dr. Nicholson's collection and two others were collected by me in Tasmania in various localities; they differ from the mainland species by the dark markings of their wings.

Genus PARATRIZYGIA, nov.

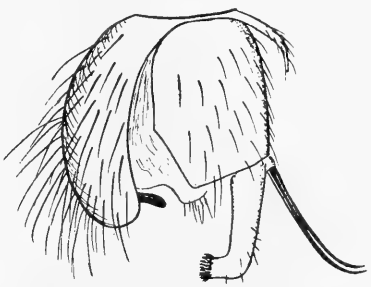
Head flattened dorsoventrally, a little higher than wide; eyes hairy, emarginated above base of antennae; ocelli 3, the median one much smaller and only a very little more forward than the lateral ones which are touching the eye margins; antennae rather longer than the thorax, 2 + 14 segmented. Segments of flagellum cylindrical, longer than wide. Palpi 4-segmented, the first very small, last somewhat smaller than the others. Thorax moderately arched. Pubescence and bristles of mesonotum irregularly arranged. Only the pleurotergites and postnotum with some pubescence, which is rather scanty on the latter. Abdomen only a little longer than the thorax; seventh segment barely visible. Legs rather short and robust. Mid and hind tibiae with two rows of subdorsal bristles which are shorter than the tibial diameter. Apical spurs 1.2.2, the internal ones shorter. Claws dentated. Empodium distinct, only the internal hind tibial combs present. Wing venation as on Plate xxiii, fig. 14; Sc_2 absent; R_4 present; M_{1+2} not branched; M_3 detached; An. not distinct; micro- and macrotrichia both present, the latter mostly on the apical portion of the wing.

Genotype, *P. conformis*, n. sp.

This genus differs from *Trizygia* by the absence of Sc_2 and the presence of R_4, which forms the little submarginal cell typical of the Sciophilini and by the absence of hairs on both anepisternites and subalar knob; in this last respect it comes near *Aphelomera*, from which it differs, however, by the much more robust habitus and complete M_1. It differs from *Neotrizygia* Tonn. in r-m being oblique and not longitudinal and in Sc ending in the costa and not in R_1, besides having the sides of the thorax bare.

PARATRIZYGIA CONFORMIS, n. sp.

♂. Head, thorax and abdomen blackish-brown, somewhat shining; humeri ferruginous; mouth parts and antennae dark brown. Halteres yellow, the knob elongate. Legs somewhat paler brown than the body, especially the front pair. Tibial spurs orange; all bristles and hairs of body brown. Wing as in Plate xxiii, fig. 14; apical portion infuscated especially on the anterior border. Hypopygium as in Text-figure 4.



Text-fig. 4.—Hypopygium of *Paratrizygia conformis*, n. sp.

Length of wing and body, 2·5 mm.

Holotype: Cradle Valley, Tasmania, 29th January, 1923 (Tonn.).

Another species with paler legs and body has also been collected at Mt. Farrel and Mt. Field in Tasmania.

Genus Aphelomera Skuse.

This very characteristic genus was erected by Skuse to receive one species from New South Wales, *A. sydneyensis*. Besides this one, I know two others from Tasmania, so that many more may be expected in the future. Seven species have been found so far in New Zealand. The genus is common to Australia and New Zealand. The wing venation is illustrated by Skuse (1888*b*, Plate xxxii, fig. 13).

Genus Paramorganiella, nov.

Head somewhat flattened dorsoventrally, longer than broad; eyes scarcely hairy and only very little emarginated near the base of the antennae; ocelli 3, nearly in a line, the middle one smaller than the lateral ones; far removed from the eye-margins; antennae as long as thorax; 2 + 14 segmented. Segments of the flagellum longer than wide, except the last two; mouth parts elongate, about two-thirds as long as the head, at least in the male, the elongation being due to that of the labium. Palpi long, the third segment modified so that both palpi can be used as prehensile organs in a mandible-like manner. Thorax moderately arched. Anepisternum and subalar knob bare but pleurotergites, postnotum and hypotergites hairy. Abdomen not quite twice as long as the thorax. Seventh segment visible. Legs moderately long. Hind tibiae with three rows of small bristles, two subdorsal and one internal, whereas the mid tibiae have a ventral row as well. Apical tibial spurs 1.2.2, the internal ones somewhat longer; only hind internal combs present but not very evident. Claws simple; empodium distinct. Wing venation as on Plate xxiii, fig. 15; Sc reaching half the wing length; Sc_2 placed near its end; r-m longitudinal; costa produced over the tip of R_5; M_3 incomplete at base; An. interrupted; micro- and macrotrichia present, the latter erect but not pointing towards the base of the wing.

Genotype, *P. adventurosa*, n. sp.

By its venation this genus comes near to the New Zealand genus *Morganiella* Tonn., especially in the arrangement of the anterior veins, Sc being long and Sc_2 placed after the origin of Rs, whereas the basal section of this vein is transverse and r-m longitudinal. However, in this new genus it is the anterior fork which is incomplete, M_2 being detached at the base.

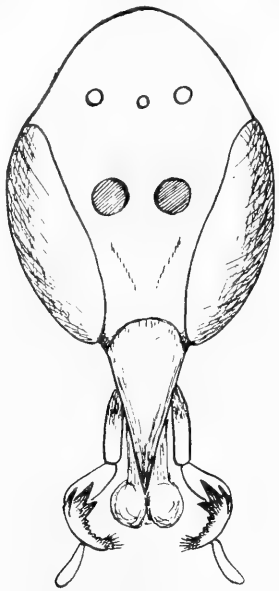
Paramorganiella adventurosa, n. sp.

♂. Head, thorax and abdomen shining black; face and mouth parts dark orange; base of antennae ferruginous, the rest brown. Humeri yellow, as well as halteres which have an elongated knob. Front legs yellowish, except base of coxae and the end of tarsi. Mid and hind legs with brown coxae and femora. Tibiae yellowish, the hind ones dark at tip. Tibial spurs orange. Wings hyaline, very slightly infuscated on the anterior border. Length of body and wing, 3 mm.

Holotype: Adventure Bay, Bruny Island, Tasmania, 30th December, 1922 (Tonn.).

The adaptation of the palpi of this species so as to make them suitable as prehensile organs is most extraordinary. This feature is depicted in Text-figure 5 and gives a better idea of the modification of the third segment of the palpi than a long description would do. The fact that their teeth and serrations are opposed and come to meet at the end of the proboscis suggests that they fulfil the rôle of mandibles, although what is known of the diet of the adult Fungus gnats does

not allow us to assume that they have carnivorous habits. Some species live on pollen, but it is hardly possible that such an armature would be needed to gather it; the labella are usually quite sufficient for this purpose.



Text-fig. 5.—Head of *Paramorganiella adventurosa*, n. sp. seen from above, but with antennae removed and showing the mouth parts with the peculiar adaptation of the palpi as prehensile organs.

The unique specimen of this species is a male, the female being yet unknown. It is, therefore, possible that this is a sexual character and that the palpi of the latter sex are quite normal. Such a modification of the palpi is quite unknown among the Diptera, but A. Philpott has described similar features in some Australian Lepidoptera (Proc. Linn. Soc. N.S.W., 1, 1925, 381) which are present also only in the males and the function of which remains unexplained. In that case the grasping function takes place between two segments of one palpus, whereas in *P. adventurosa* the grasping is done between both palpi.

Genus Synapha Mg.

A species closely related to some New Zealand ones has been found in different localities in Queensland and Southern Tasmania. The wing venation is given on Plate xxiii, fig. 16. This genus is known so far only from Europe, South America and New Zealand where seven species have been found. The presence of R_4 is not diagnostic; it is missing in the Tasmanian species.

Genus Austrosynapha, nov.

Head nearly round; eyes not distinctly emarginated near the base of antennae, distinctly hairy; ocelli 3, median smaller and placed distinctly more forward; mouth parts but little produced; palpi 4-segmented, the first very small,

the others subequal; antennae longer than the thorax and rather thin; 2 + 14 segments. Segments of flagellum three to six times as long as wide; second segment with some long dorsal bristles. Thorax highly arched and with long curved bristles on dorsum. Abdomen elongate, about twice as long as thorax; second segment visible. Legs rather slender. Tibiae with two or three rows of small bristles; tibial spurs 1.2.2, the internal ones slightly longer; internal hind tibial combs not evident, with only four setae. Empodium not distinct. Claws simple. Wings with Sc_1 rather long but abruptly interrupted; Sc_2 absent; costa produced well over the tip of Rs; basal section of Rs perpendicular; r-m oblique and moderately long; stem of M_{1+2} rather long; this vein and its fork weak; M_2 also weak; An. incomplete (see Plate xxiii, fig. 17).

Genotype, *Austrosynapha hirta*, n. sp.

This genus differs from *Synapha* by Sc_1 ending free and Sc_2 absent. At first one would consider it as a subgenus of *Synapha*, but the venational character given by the incompleteness of Sc ranks rather high, perhaps unduly, in the classification of the Mycetophilidae. The reduction of Sc places this form between the Gnoristini and the Leiini but, as it is in all respects very close to *Synapha*, I think it will be preferable to include it in the former tribe.

Austrosynapha hirta, n. sp.

♀. Head, thorax and abdomen dull brown; the vertex darker, mouth parts and antennae brownish; base of the latter somewhat paler. Prothorax with three long curved bristles on each side converging inwards. Disc of mesonotum with three darker vittae converging behind, and along each of which runs a row of long curved bristles and some smaller hairs; elsewhere the notum is bare except on the sides. Two long apical scutellar bristles. Halteres with yellowish stem and dark knob. Legs, including coxae, yellowish. Femora and tibiae darker. Tarsi still darker. Pubescence and bristles brown. Wings hyaline; venation as on Plate xxiii, fig. 17.

Length of body and wing, 3·5 mm.

Type: Mt. Wellington, Hobart, 27th November, 1922 (Tonn.). Paratype: Burnie, 26th October, 1922 (Tonn.).

Genus Pseudalysiinia, nov.

Head somewhat wider than high; eyes round, bare; fronto-clypeus circular, separated from the vertex by a deep circular suture; ocelli very close to eye-margin, but not quite touching; the median one missing. Labellum short, flat and round. Palpi rather long, 4-segmented, the first one small, the others gradually increasing in size, the second one incrassate. Antennae rather thick, filiform; 2 + 14 segmented, nearly as long as the body in the male, about half as long in the female. Segments of flagellum about four times as long as wide, densely hairy. Thorax moderately arched, overhanging the head as is usual in many Chironomids. Thorax with a few very indistinct microscopic hairs, but absolutely devoid of bristles. Abdomen subcylindrical in male, flattened dorsoventrally in female, with six visible segments only. Hypopygium of complicated structure, similar to that of some species of *Phronia*. Coxae relatively small for a Mycetophilid. Legs devoid of bristles. Only one tibial spur present on each leg and quite small. Claws toothed. Empodium large. Wings with Sc long, ending in R_1, basal section of Rs vertical; r-m somewhat oblique and short; stem of median fork very short,

shorter than r-m; posterior fork under that of the media; An. strong but abruptly interrupted (see Plate xxiii, fig. 18).

Genotype, *P. mimicans*, n. sp.

On account of its venation, this genus is very near *Dziedzieckia*, especially on account of Sc ending in R_1, but here R_1 is missing and the median and posterior forks are closer together; as far as other characters are concerned, the affinities are difficult to make out on account of its peculiarities, such as the conformation of the head with only two ocelli nearly touching on the eye-margin, and the structure of the fronto-clypeus; these characters, and also the general structure of the hypopygium, show some affinities with the Mycetophilini. Here, however, the antennae are erect, instead of recumbent as is mostly the case in the latter subfamily. Edwards (*in litt.*) suggested that there might be a relationship with *Ohakunea* Edw. of the Sciarinae, but the analogy is absolutely superficial and is suggested only by the similarity of colouring, bright orange thorax, black abdomen and smoky wings. *Pseudalysiinia* has no bridged eyes, Sc is long and ends in Rs, r-m is oblique, etc.; also the complexity of the hypopygium structure is not all Sciarinae-like. This genus must, I think, be placed amongst the Gnoristini on account of the bareness on the sides of the thorax and postnotum, the absence of microtrichia on the wing membrane, and the fact that the microtrichia are not arranged in definite rows as in the Mycetophilinae, and also on account of the long Sc_1, the long last section of R_1 and the seventh abdominal segment retracted. This genus is very remarkable amongst the Mycetophilidae by the complete absence of bristles on the body and legs and by the unique apical tibial spur remaining on each leg.

PSEUDALYSIINIA MIMICANS, n. sp.

♂. Head brown above, orange on face and below; antennae with first two segments orange, the rest deep black with black pubescence. Palpi brownish. Proboscis orange. Thorax bright orange, especially on the disc of mesonotum;

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Text-fig. 6.—Hypopygium of *Pseudalysiinia mimicans*, n. sp.

on the whole, but little shining; deep post-humeral foveole and some along the side margin of mesonotum as well as in the front and at base of scutellum. Halteres and legs orange. Tibiae brownish, gradually infuscated distally, the front ones paler, tarsi blackish. Small tibial spurs orange. Abdomen dull velvety-black with sparse, darkish inconspicuous pubescence. Hypopygium of complex structure as shown in Text-figure 6. Wing evenly blackish; venation as on Plate xxiii, fig. 18.

Length of wing and body, 4 mm.

Holotype: Cradle Valley, Tasmania, 12th January, 1923 (Tonn.).

Female similar to male, antennae smaller, abdomen much wider distally, femora darker.

Allotype: Mt. Wellington, Hobart, 2nd December, 1922 (Tonn.). Paratypes: With the type in Adventure Bay, 30th December, 1922; Mt. Farrel, 9th February, 1923; King River, 4th February, 1923.

This most remarkable species mimics a small species of Braconid of the tribe Alysiini which is on the wing in the same localities as *P. mimicans* and which exhibits very exactly the same coloration of body and wings.

Genus Clastobasis Skuse.

One species, *C. tryoni*, from Queensland was included by Skuse in this genus, which is so far known only from Australia. The new genus *Paradoxa* Marsh. is very closely related, the only apparent difference being in the costa not produced over the tip of Rs, and An. not running into Cu in *Clastobasis*, the venation of which has been depicted by Skuse (1890*b*, Plate xix, fig. 6).

Genus Ateleia Skuse.

The venation of this genus is very close to that of the New Zealand genus *Cawthronia* Tonn., from which it differs in the presence of Sc_2, the interruption of M_1 at the base and the position of the origin of Rs, which is placed very near the tip of R_1. If this were the only difference between the genera, *Cawthronia* could be sunk under *Ateleia*, but as I have not seen the genotype of the latter, and as, from Skuse's description, it seems that *Ateleia* is a slender insect whereas *Cawthronia* is very thick-set, with short legs and short antennae, the segments of the flagellum generally much wider than long, I think they had better remain separate for the present. Only one species has been described by Skuse under this genus, *A. spadicithorax* from Bowral, N.S.W. Its wing venation is given by Skuse (1888*b*, Plate xxxii, fig. 11).

Genus Leia Mg.

One species from Tasmania, *L. fulva* Walk., is the only one recorded, and it has apparently never been found since; it is impossible to say from Walker's scanty description if it really belongs to the genus *Leia*. However, this genus exists in Tasmania, as I found there two other apparently undescribed species which agree well with the characteristics of the genus, except that in one of them M_3 is slightly detached at the base so that it comes near the venation of *Acrodicrania* in that respect. *Leia* is known from practically all over the world.

Genus Acrodicrania Skuse.

This genus seems to be well represented in Australia from whence four species have been made known by Skuse. I have seen besides these, two others in Dr. Nicholson's and Dr. Mackerras's collections, and I have found four in Tasmania which seem different from the mainland forms. In his key to the genera, Edwards distinguishes this genus from *Anomalomyia* Hutton by An. strong and distinct and by the absence of Sc_2. However, a study of the above-mentioned Australian species of *Acrodicrania* and of several New Zealand species of the genus *Anomalomyia* Hutton shows that there are no definite limits between the two

series of forms. In a specimen in Dr. Nicholson's collection, Sc_2 is present and An. is strong, whereas in some New Zealand species of *Anomalomyia* An. may be strong and in others it is faint or absent, while in one M_3 is slightly detached at the base, a character which is usually found in the Australian species of this group. I think, therefore, that it would be advisable to sink *Anomalomyia* under *Acrodicrania*, which has priority. There seems to be also little demarcation between *Acrodicrania* and *Leia*, as the only difference is found in the prolongation of the costa over the tip of Rs in the former genus and that M_3 is practically never detached at the base in *Leia*. The wing venation of *Acrodicrania* is figured by Skuse (1888*b*, Pl. xxxii, fig. 10).

Genus Tetragoneura Winn.

This genus, well represented in New Zealand by fourteen species, and known otherwise only from Europe, occurs also in Tasmania, where three species have been so far found. The wing venation is shown on Plate xxiii, fig. 13; R_4 may be either completely absent or present even in a given species.

Genus Paraleia, nov.

Head nearly as wide as high, eyes but slightly emarginated near the base of antennae but yet not round, and distinctly hairy; ocelli 3, in a line, the median one smaller, the lateral ones close to the eye-margins, but distant from them about their own diameter. Fronto-clypeus rounded and produced, palpi rather long, the segments gradually increasing in length. Antennae about as long as the thorax in the male, shorter in the female, 2 + 14 segmented. Segments of the flagellum about three times as long as wide. Thorax moderately arched; mesonotum bare on the disc, except for three rows of bristles and small hairs; pleurae and postnotum bare, about one and a half times as long as the thorax, seventh segment not visible. End lamellae of female much elongated. Legs rather long, tibial bristles long, arranged in rows on mid and hind tibiae, tibial spurs 1.2.2, subequal to each other. Claws toothed. Empodium well developed. Wing elongate; costa produced over the tip of Rs, otherwise the venation is identical with that of *Leia* (see Plate xxiii, fig. 19).

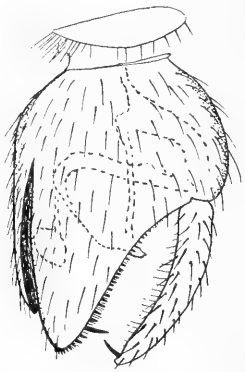
Genotype, *P. fulvescens*, n. sp.

This genus is closely related to *Leia* on account of its venation, both forks being complete, but the costa is produced over the tip of Rs. However, it differs rather widely in the non-bulging and bare pleurotergites, also in the shape of the head, with much narrower front, the ocelli not touching the eye-margins but grouped together; different features can be found also in the mesonotum, devoid of regularly disposed pubescence, but provided with five rows of small and large bristles, and also in the elongated wings.

Paraleia fulvescens, n. sp.

♂. Head orange, vertex brown; mouth parts orange; first three antennal segments orange; fourth and following ones more or less extensively orange at base and brown distally; last ones completely brown. Thorax orange, rather shining on the mesonotum, less so on sides and on postnotum; pronotum with two long yellow bristles curved inwards on each side, long curved bristles of the mesonotum brownish, those of the single acrostical series all small; edge of scutellum with two long bristles and a row of about six between them. Halteres yellow-orange. Abdomen with tergites mostly light brown, the first and second on

the disc only, the following ones completely, with the exception of a more or less narrow posterior border; venter and hypopygium orange, the latter as in Text-figure 7. Legs entirely yellow, the tarsi darker, mid tibiae with two internal, three



Text-fig. 7.—Hypopygium of *Paraleia fulvescens*, n. sp.

anterior and four dorsal bristles; hind tibiae with 2.4.4 bristles. Wings nearly uniformly yellowish with yellow veins. Venation as on Plate xxiii, fig. 19. Base of the radius carrying four strong bristles.

Length of body, 3 mm.; wing, 4 mm.

Type: Eaglehawk Neck, 28th November, 1922 (Tonn.).

♀. Similar to male, end lamellae as long as median segment of abdomen and apparently bi-segmented.

Allotype: St. Patrick River, 30th October, 1922. Paratypes: Tasmania: Wilmot, 8th January, 1923; Burnie, 1st February, 1923; Ferntree (Mt. Wellington), 11th November, 1922. New South Wales: Barrington Tops. Queensland: Townsville.

This does not seem to be *Leia fulva* Walker on account of the yellow wings with yellow veins.

Subfamily Mycetophilinae.

Genus Exechia Winn.

Five species of the genus, all from New South Wales, have been described by Skuse, who erected the new genus *Brachydicrania* to receive them. I know three other species from Tasmania, and one from Victoria, which do not seem to correspond to any of those described by Skuse. All these Australian species do not belong to the same group as the New Zealand ones, R_5 being less curved and M_1 scarcely, if at all, sinuous. The venation is figured by Skuse (1888*b*, Plate xxxii, fig. 17). This genus is distributed all over the world.

Genus Rhymosia Winn.

From the examination of Skuse's paratypes loaned by Dr. Nicholson, I see that *Symplasta annuliventris* is a species of *Rhymosia*, not an *Allodia* as suggested by Edwards (*Trans. Ent. Soc. Lond.*, 1925, 604), as An. is present and strong, as shown on Plate xxiii, fig. 20, which can be compared with that of the wing of a true *Allodia* shown in fig. 21. This vein is not shown in Skuse's drawing (1890*b*.

Plate xix, fig. 10). The vein depicted under the posterior fork appeared to be Cu_2, and it ends distad of the fork, whereas An. ends distinctly proximad to it. There is also another still undescribed species which seems to be very common in New South Wales; I have collected it also in Victoria and in many localities in Tasmania.

Genus Allodia.

This cosmopolitan genus has so far not been recorded from Australia, *Symplasta annuliventris* Skuse being in reality a *Rhymosia* as pointed out above. However, one species is known to me from different localities in Tasmania. Others representative of this genus will certainly be found on the mainland. Venation as on Plate xxiii, fig. 21.

Genus Dynatosoma Winn.

The species *D. sydneyensis*, which Skuse refers to this genus, is a species of *Rhymosia* apparently identical with *Rhymosia* (*Symplasta*) *annuliventris*, the hypopygium of a male paratype agreeing with that of a paratype of the latter species. However, I have not seen the types of either species, and without comparing them it would be premature to conclude as to the identity of the species. The female paratypes of both species which I have seen also agree in every respect. The vein An. is as distinct as in the male, but noticeably shorter. The tibial bristles of *D. sydneyensis* are not sufficiently long and strong and it is to be wondered why Skuse included the species in *Dynatosoma*, especially as he did not see any difference in the venation, his two figures 8 and 10 (1890*b*, Plate xix) being almost identical. He may have been misled by some slight difference due to sex, his type of *D. sydneyensis* being a female and that of *R. annuliventris* a male.

Genus Trichonta Winn.

Two species of this genus have been described by Skuse, each from a unique specimen, the types of which I have not seen. It is not possible to deduce from their descriptions whether he placed them in the right genus; judging from his figure of the venation (1888*b*, Plate xxxii, fig. 14) they might be some species of *Rhymosia*. I have not seen any other Australian representatives of the genus.

Genus Mycetophila Mg.

It is surprising that this genus is not better represented in Australia, as more than fifty species are so far known from New Zealand. I have found about fifteen species in Australia and Tasmania, some of which undoubtedly belong to the three described by Skuse and Walker. The wing venation is given by Skuse (1888*b*, Plate xxxii, fig. 15).

Genus Delopsis Skuse.

Only one species, *D. flavipennis*, the genotype, is known. The wing venation is figured by Skuse (1890*b*, Plate xix, fig. 7).

Genus Zygomyia Winn.

This genus, so abundantly represented in New Zealand by about thirty species, is known to me from Australia only by one species collected in Victoria (see venation, Plate xxiii, fig. 22).

Genus Sceptonia Winn.

Only one species, *S. ornatithorax*, has been included by Skuse in this genus. I have not seen the type, a unique specimen. Skuse does not give a figure of the venation, but from his description there seems to be no doubt as to the generic position of this species.

Summary.

In this paper a review is made of what was known of the Australian Mycetophilid fauna up to date. A list of the genera is given, to which twenty-one are added to those previously known from the different States, the total being forty-seven. Ten of these genera have been proposed as new.

The affinities of this Australian Mycetophilid fauna are discussed and some of the morphological features, especially the venation, necessary for classification are explained.

A key is given to all known subfamilies and genera of the world.

A peculiar adaptation of the palpi as a prehensile organ in a species of *Paramorganiella* is made known and illustrated. A second case of mimetic resemblance of a Mycetophilid, *Pseudalysiinia*, with a Hymenopteron is brought to light.

The wing venation of all the Australian genera or of those which have not been depicted by Skuse, is illustrated.

EXPLANATION OF PLATES XXII–XXIII.

Plate xxii.

1. *Centrocnemis* sp.
2. *Arachnocampa luminosa* Sk.
3. *Diadocidia* sp.
4. *Neoantlemon apicalis*, n. sp.
5. *Nicholsonomyia vespiformis*, n. sp.
6. *Pareudicrana monticola*, n. sp.
7. *Allocotocera* sp.
8. *Neoallocotocera fusca*, n. sp.
9. *Tasmanina gracilis*, n. sp.
10. *Aneura* sp.
11. *Phthinia* sp.
12. *Austrosciophila solitaria*, n. sp.

Plate xxiii.

13. *Tetragoneura* sp.
14. *Paratrizygia conformis*, n. sp.
15. *Paramorganiella adventurosa*, n. sp.
16. *Synapha* sp.
17. *Austrosynapha hirta*, n. sp.
18. *Pseudalysiinia mimicans*, n. sp.
19. *Paraleia fulvescens*, n. sp.
20. *Rhymosia* sp.
21. *Allodia* sp.
22. *Zygomyia* sp.

The photographs were taken by Mr. W. C. Davis.

AUSTRALIAN RUST STUDIES. I.

By W. L. Waterhouse,
The University of Sydney.

(Plates xxiv-xxvii.)

[Read 27th November, 1929.]

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Introduction.

Cereals are the most important of the crop plants grown in Australia. Wheat is the most widely grown of the cereals, being one of the staple products of the country. This is indicated by the fact that in the season 1927-1928 there were 12,263,979 acres under wheat, yielding a total of 116,737,082 bushels. Far-reaching benefits will therefore accrue from anything which can be done to eliminate losses in the yield. That great losses do occur is well known and, amongst the causal agents, plant diseases reduce yields in a remarkable degree. The disease known as rust is no exception.

A detailed account of the history of cereal rusts in Australia is beyond the scope of this paper. A great deal of information has been compiled, but from it only a few brief extracts will be given.

Rust occurred in wheat in the very early days of colonization of Australia. It was one of the many obstacles encountered. The difficulties met with by the early settlers in their wheat-growing have been reviewed by Potts (1924), but some further references to the original accounts may be of interest.

The earliest available record is that written by David Collins, the Secretary to the first Governor of the Colony. Writing in February, 1788, of the disembarkation of the first colonists, Collins (1798) refers on page 7 to the clearing of a

piece of land—the site of the present Botanic Gardens—where wheat was first sown. In August of the same year, referring to this land, he says (p. 41): "The seed wheat that was sown here did not turn out any better than that at Norfolk Island: in some places the ground was twice cropped, and there was reason to apprehend a failure of seed for the next year." The next reference on p. 88, written in December, 1789, states, "In the course of this month the harvest was got in; the ground in cultivation at Rose Hill produced upwards of 200 bushels of wheat, about 35 bushels of barley, and a small quantity of oats and Indian corn; all of which was intended to be reserved for seed. At Sydney, the spot of ground called the Governor's Farm had been sown only with barley, and produced about 25 bushels."

Collins, on p. 442, writing of December, 1795, says, "The harvest was begun this month. The Cape wheat (a bearded grain differing much from the English) was found universally to have failed. An officer who had sown 7 acres with this seed at a farm in the district of Petersham Hill, on cutting it down found it was not worth the reaping. This was owing to a blight; but everywhere the Cape wheat was pronounced not worth the labour of sowing." The "*blight*" may well have been a plant disease, possibly rust. "Petersham Hill" includes the present site of the University of Sydney.

Early despatches from Governor Hunter published in the "Historical Records of Australia" give further information regarding these happenings. A communication written in March, 1796, (p. 554) states, "We have got our harvest in, and it is, upon the whole, in point of quantity as well as quality, very superior to anything which this country has before experienced, although a few blights and other accidents had disappointed the expectations of some very industrious settlers." In a further despatch (p. 557) dated April of the same year is another reference to this "destruction of the crops of some of the settlers by blight". The estimated wheat yield in that year was from "35,000 to 40,000 bushels". The acreage under wheat was stated to be 2,721½ acres, so that the harvest yielded an average of from 12 to 14½ bushels per acre.

Rumsey (1915) refers to the first recorded attack of rust in Australia. It occurred in the Dundas district at Brush Farm owned by Captain Cox. This is close to the present Eastwood Station. What is evidently a quotation from the *Sydney Gazette* reads as follows:—

"October 21, 1803. A more beautiful appearance of a successful harvest never flattered the expectations of a farmer within 3 weeks of being ripe; ears were full, plump and well coloured, and in every respect gratifying to look at. In 3 days it was completely destroyed by rust. The produce of 266 acres was not worth £20. A loss of £4,000 was made,—an enormous amount in those days." Potts (1924) quotes this same statement. Maiden (1906) states that rust attack was the reason for wheat-growing being discontinued at Farm Cove.

Atkinson (1826) refers to the prevalence of smut in the wheat crops, and says (p. 43) that "rust sometimes appears, but is not very common".

Montague Smith (1818, p. 9) notes that the plains and forest lands of the Hunter River district of New South Wales suffered from rust in wheat. He states that the only places which escaped were patches of virgin soil, although the weather conditions were favourable for rust development.

Even with the extension westwards into the drier climates, rust damage was not eliminated. Severe losses occurred from time to time in the various States. Grove (1913, p. 253) states that in 1889 when there was a wet and muggy spring, the loss due to rust for the whole of Australia was estimated to be between

two and three million pounds sterling. The importance of this "red rust" led to the convening of conferences of delegates from the different States to consider the problem. Several of these conferences were held, commencing in the year 1890. The work of these conferences is summarized in various numbers of the *Agricultural Gazette of New South Wales* (1891, 1892, 1896). Only one of the full reports has been available for consultation. It gives interesting sidelights on the problem as it existed then, and impresses one with the enthusiasm and soundness of the workers in those days. It must be remembered that what are now commonplace facts regarding rust were then quite unknown.

At the "Rust in Wheat Intercolonial Conference" held in 1892 figures were given which showed the importance of the disease. Anderson (p. 13) estimated the damage done in 1891–1892 season at more than two bushels per acre sown. This season was stated to have been a favourable one as regards small loss from rust.

McAlpine (p. 18) considered that the loss in Victoria that year varied from two bushels to twelve bushels per acre, and in some instances more. Farrer at this conference (p. 25) affirmed that he had the greatest faith in the world that the solution to the rust problem could be found.

Cobb (1890, 1892, 1893, 1894) broke much new ground in his rust investigations and made many contributions to the subject. It is interesting to find Sir J. B. Lawes (1892) expressing the opinion that the solution would be found in a rust-proof variety of wheat.

McAlpine (1906) has made the most valuable contribution to our knowledge of Australian rusts. It is the only work of its kind available.

Despite the wonderful wheat-breeding work done by Farrer, losses from rust continued. Thus in 1903 the New South Wales losses through rust attack were estimated by Mr. A. H. E. McDonald, then Chief Inspector of Agriculture, to amount to nearly 3,000,000 bushels, worth more than £400,000. The same authority computed the rust loss in 1916 at more than 5,000,000 bushels, the damage totalling over £2,000,000.

Following the lead given by Farrer, attention has been paid by wheat-breeders to selection for rust-resistance. Considerable success has been achieved in this work. An even greater saving has been effected through the development of rust-escaping varieties. These mature early enough to lessen greatly, and frequently to render negligible the attack by rust.

Although there has been no serious widespread rust epidemic in New South Wales since 1916, rust still causes heavy losses in some seasons. In the absence of published data on a plant disease survey, reference is made to various statements published by field officers of the Department of Agriculture.

Referring to the 1917 season, Pridham (1918) says, "Rust greatly affected the yields, and the best results were obtained from early-maturing varieties". Stening (1918), speaking of the same season, reports, "The rains and muggy weather in spring following upon the abundant winter rainfall supplied very favourable conditions for the development of red rust, which at the time of judging was present on stem and ear." Another statement dealing with the 1917 season by McDiarmid (1918) is as follows:—"The season was not so conducive to rust as the previous one, and only occasional areas were affected to any extent."

The 1920 season is also commented upon with regard to rust. Reynolds (1921) says, "Rust was markedly showing on stem and flag, causing slight pinching of the grain." Birks (1921) reports that, "Rust had everywhere established itself

in the more susceptible varieties, but thanks to the dry spell in October, little damage is to be anticipated." Shepherd (1921) states that, "Hard Federation .... in some instances was badly attacked by rust."

The next year rust is also referred to. Birks (1922), dealing with the North-western Slopes and Plains, says, "So general is the threat of rust that rust-resistance is one of the main considerations in the selection of varieties for the district." Reynolds (1922) states, "It was again noticed that Federation and Hard Federation were both severely affected with rust." Referring to the Corowa district, Sparks (1922) reports that "rust was very prevalent, some of the crops being severely attacked".

Writing of the 1924 harvest in the North-western District, McCauley (1925) refers to "losses of over 50 per cent. of the expected yield in some cases". Reynolds (1925) states that in the Northern District in that year "stem and flag rusts made rapid progress, and caused pinched and light grain".

In the 1928 harvest losses are reported. Kerle (1929) estimated losses in parts of the Central-western District at 50 per cent. of the expected yield. Medley (1929) states that "stem rust alone was responsible for a general reduction in yield by at least 20 per cent., while in varieties showing a heavy infection the yield was reduced by fully 50 per cent." Bartlett (1929), referring to the same season, remarks that "Eastern Riverina just escaped a very serious outbreak of rust".

In 1915 the late Captain H. Stephens was appointed the first Walter and Eliza Hall Agriculture Research Fellow of the University of Sydney. He commenced an investigation of the rust problem, but after holding the Fellowship for only three months, enlisted for active service overseas. Science in general and Australia in particular suffered a great loss when he was killed in action. Results of the greatest value would certainly have been forthcoming had he been spared to carry forward the work which he so ably began.

In 1918 the writer was appointed to the Fellowship left vacant by the death of Captain Stephens, and upon returning from abroad in 1921, the studies herein recorded were commenced.

The nature of the problem demanded extensive studies as well as intensive research into many aspects of the subject. Whilst definite conclusions are now possible from some of the lines of work, in others it will be many years before definiteness can be reached. But some of the general results obtained seem worth recounting at this stage. These largely have to do with investigations carried out in the plant house, the only practicable method to follow if full control of the work is to be maintained. But as far as possible attention has also been given to field results. In this work particularly the cooperation with the New South Wales Department of Agriculture has been invaluable.

The work deals with rusts present on cereals and certain of the grasses. On wheat, the only rusts recorded in Australia are *Puccinia graminis tritici* E. & H. which causes stem or black or summer rust, and *P. triticina* Erikss. which causes orange leaf rust or spring rust. The yellow stripe rust caused by *P. glumarum* (Schm.) E. & H., has not been recorded. On barley two rusts occur, *P. graminis tritici* E. & H. which causes stem rust, and *P. simplex* (Körn.) E. &. H. which causes leaf rust. On oats there are two rusts, *P. graminis avenae* E. & H. which produces the stem or black or summer rust, and *P. coronata* Cda. which causes the crown or leaf rust. There are also two rusts on rye, *P. graminis tritici* E. & H. the cause of stem or black or summer rust, and *P. dispersa* E. & H. which causes leaf rust. The genetic connection between these cereal rusts and certain of the rusts on grasses is discussed later in this paper.

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THE AECIDIAL STAGE OF PUCCINIA GRAMINIS.

This stage in the life history of *Puccinia graminis* is of extreme importance in the Northern Hemisphere. The eradication of barberries in Denmark, according to Lind (1915), has led to a most marked reduction of stem rust in that country. The barberry eradication campaign in the United States of America has repeatedly shown that the destruction of barberries results in a diminution of rust attack. More recently (Waterhouse, 1929) it has been shown that physiologic forms may originate in this stage on the barberry.

Results in 1921.

Prior to 1921 it was believed that the Australian stem rust was incapable of infecting the barberry. In October of that year it was shown (Waterhouse, 1921) that teleutospores from wheat straw grown at Glen Innes produced normal infections of a susceptible barberry growing in the open at the University of

Sydney. Inoculations of seedling wheat plants with aecidiospores from the aecidia on this barberry gave rise to the uredospore stage. This culture was studied in regard to its specialization, as was also the English culture referred to in the same paper. The latter was found to be Form 27. Both were kept in culture for several years and frequently tested on the differential hosts to be certain of their identity. The Australian culture proved to be Form 46. It was kept in culture in the plant house for four years and used in various tests. This same form was isolated from uredospore material on wheat sent from exactly the same locality in December, 1921, and again in December, 1922.

Results in 1922.

In March rusted wheat straw was received from Pusa, India. It was exposed to winter conditions at Hawkesbury Agricultural College until October, when the teleutospores gave abundant germination. They were then used for barberry inoculations. Sixteen days after the date of inoculation, spermagonia and aecidia were produced. Aecidiospores were used to inoculate "Federation" wheat seedlings, but without result. No reason could be given for the failure. A recent visitor from India, Mr. Robertson Brown, has stated that "Federation" grown in India is resistant to stem rust, although other varieties are very susceptible. This may perhaps explain the negative result obtained. Nevertheless a later test with rust from this locality gave Form 16. "Federation" is quite susceptible to this form.

Results in 1923.

In April, when the positive results from the teleutospore germinations of Hawkesbury Agricultural College material were unexpectedly found, barberries which had been cut back and were putting out new growth were inoculated with the viable teleutospores. No infections were obtained. The form of rust used in this test was Form 43.

In the same month, a package of wheaten straw showing heavy teleutospore infections of stem rust was received from A. D. Cotton, Esq., of Kew, England. The straw had been collected by Miss K. Sampson at Milton, Wales, and then exposed to winter conditions until March, when it was forwarded to Sydney. Upon arrival the teleutospores were viable, giving abundant germinations. Barberry plants (some of them the identical plants used for the above-mentioned Hawkesbury Agricultural College work) were successfully inoculated, spermagonia beginning to show in eight days and aecidia in twelve days. From inoculations of Federation wheat with aecidiospores, the uredospore stage was produced. This proved to be Form 27. It has since been kept in culture and is still alive. It was interesting to find that the form (27) was the same as that which had been obtained in the 1921 work from straw collected at the same place.

It is clear, then, that the conditions for barberry infections were quite suitable, and that the failure to secure infections from the Hawkesbury Agricultural College teleutospore material was due to something in the material itself.

In October when the Hawkesbury Agricultural College material was giving abundant germinations, further extensive barberry inoculations were made. Again the results were negative in every instance. This seemed to indicate that Form 43 cannot infect the barberry.

Results in 1924.

At the end of September barberries were inoculated with viable teleutospores from rusted straw collected from Hawkesbury Agricultural College and known to comprise Forms 43 and 46. Spermagonia were produced but no aecidia.

Further barberry inoculations were made with material from Rutherglen, Victoria, which had been exposed at Epping, N.S.W. Uredospore tests with this same material had shown that Form 46 was present. As a result of the inoculations spermagonia were produced. The unusual incidence of a cold snap at this time checked the growth of the barberries and may have prevented the formation of aecidia.

Another batch of rusted wheat straw was received from Devonport, Tasmania, in March, 1924. Uredospore tests showed that it was Form 46. The straw, which showed heavy teleutospore as well as uredospore infections, was exposed to winter conditions at Epping, N.S.W., and tested at the end of September. It proved viable. Barberry inoculations gave abundant infections. Spermagonia and aecidia were produced in quantity. Uredospore cultures on Federation were obtained and proved to be Form 46. This culture has been frequently compared with the uredospore culture from the original straw. No differences in parasitism have been detected.

Results in 1925.

It has been pointed out that some evidence seemed to be forthcoming that Form 43 cannot attack the barberry. In this year's tests, wheat varieties were selected at Hawkesbury Agricultural College on the basis of their known reaction to Form 43 and Form 45, and teleutospore material of three varieties susceptible to each saved. As described in the account dealing with the "Teleutospore Stage", abundant germinations were obtained in September.

During September, six sets of barberry inoculations were made. The barberry plants in two of the sets were well-established bushes of *Berberis vulgaris* growing in the open, and in the other four sets, were sturdy but rather small plants growing in pots. From one set of inoculations, no infections were obtained. This set was on the outdoor plants. During the 48-hours' incubation of the young twigs in lamp-chimneys, hot dry westerly winds were experienced. Attempts were made to keep the cotton-wool plugs of the chimneys damp throughout the incubation, but it is believed that these unusual weather conditions were responsible for the failure of this set of inoculations. All the other sets in the plant house gave infections with production of spermagonia and aecidia. In every instance the infections came from the rust on Alaska Branched or American Club, which were known to be infected with Form 45. The barberries infected in this test were *Berberis vulgaris*, *B. vulgaris*, var. *sanguinelenda*, *B. Georgiana*, and *B. Lucidii*. The three last-named were grown from seed kindly supplied by Dr. M. N. Levine in 1920. No case of infection from teleutospores of Form 43 was found. A series of fixations of leaves inoculated with sporidia of Form 43 was made for sectioning and examination. The happenings in the infection of the young leaf by the sporidia had already been traced (Waterhouse, 1921) and these preparations were on hand. But a further series of fixations of leaves inoculated with sporidia from Form 45 was made at the same time and under identical conditions as those made with Form 43.

The sections of the young leaves show that the sporidia of Form 43 bring about a penetration of the cuticle in the ordinary way. In material fixed 48 hours

after inoculation, the uninucleate hyphae are present in the epidermal cells and appear to be normal in every way. Further studies of later stages in inoculations with Form 43 are in progress.

From the aecidiospores, uredospore cultures were obtained on Federation and have been studied for specialization. The form agrees closely with Form 45. On the ordinary basis for determination, it is classed as the same. That is to say, both must be listed as showing a resistant reaction on Kanred. But there is a consistent difference between them. The stock culture of Form 45 gives no infection whatever on Kanred. The aecidial culture—tentatively listed as 45A—has always given a "2" reaction on this host under the same conditions. The same consistent differences are shown on the Kansas wheats forwarded by Dr. L. E. Melchers under the names P762, P1066, and P1068, as well as on several other varieties. A further interesting difference between the stock culture of Form 45 and this aecidial culture called 45A is shown later in connection with the biometrical study of the uredospores. Here it is found that the spores of Form 45A are very significantly narrower than those of the stock Form 45.

Further Results.

In 1926 teleutospores of Forms 34, 43, and 45 were viable in September. In that month and in October, inoculations of barberries were made, with negative results in each case. On both occasions hot dry conditions prevailed during the incubation period out of doors and are believed to have been responsible for the failure.

In 1927 viable teleutospores on wheat straw from India and of Forms 34 and 45 together present on straw from Glen Innes were used. Barberries were inoculated at the end of September. The Indian material produced spermagonia only. The Glen Innes material produced spermagonia and aecidia. These were fixed and used for class preparations, not being tested in the uredospore stage.

The results obtained in 1928 were of unusual interest. They have been reported in a separate paper (Waterhouse, 1929).

In April, 1929, a parcel of oaten straw with heavy teleutospore infections was received from Miss K. Sampson of the University College of Wales. The material had been collected in County Kildare, Ireland, by Dr. Murphy. The spores proved to be viable and were used to inoculate a young barberry which, although it was autumn, was putting forth some young growth. At the same time two other barberries in pots were cut back and brought into a warm spot in the plant house where later they were used for a further series of inoculations. Very heavy aecidial infections were procured and uredospore cultures obtained on Algerian oats. One of the barberry infections is illustrated in Plate xxiv. Specialization studies (referred to later in this paper) have shown the presence of Forms 1 and 7 of *P. graminis avenae*, and that in respect of colour and spore size this rust differs from the Australian rust.

Summary.

Further evidence has been obtained to show that Australian stem-rust of wheat can attack the barberry. An exception seems to occur in Form 43. Plants of *Berberis vulgaris* known to be susceptible to other forms of *P. graminis tritici* have repeatedly failed to give infections when inoculated under ideal conditions with viable teleutospores of this Form 43. As early as 1925, from infections of a

barberry with teleutospores of Form 45, a form was isolated which resembles Form 45 but consistently differs from it in certain respects. This aberrant form has not been met with in any other isolation. Overseas teleutospores have given rise to forms unlike those present in Australia.

The Teleutospore Stage of P. graminis.

In order to link up with studies of the aecidial stage of *P. graminis*, germination studies were carried out.

Numerous attempts were made to repeat the results reported by Thiel and Weiss (1920) for hastening spore germination. Using teleutospores which had not been exposed to weather conditions throughout the winter, these workers found that as a result of treating the spores with a weak solution of citric acid, immediate germinations were obtained. Despite many attempts made in different seasons, in no instance was the result repeated. Various samples of citric acid, both "pure" and "commercial", were tried. It therefore became necessary to fall back upon the method of exposing the rusted straw to weather conditions in the open, and then testing the germination capacity.

Results in 1922.

Following upon the successful infection of the barberry which had been obtained with teleutospores from wheat straw collected at Glen Innes (Waterhouse, 1921), it was decided to test rusted material collected at other places. Wheat straw showing heavy teleutospore infection was collected from the Government Experiment Farms at Bathurst, Cowra, Glen Innes and Grafton in December of 1921. Each collection was divided into equivalent parts, of which one was sent to each of these farms to be there exposed to winter conditions. Samples of this exposed straw were forwarded to Sydney for examination at intervals.

McAlpine (1906) states that teleutospores which have been exposed to winter conditions commence to germinate in warm days about the end of September. Arrangements were made for the first batch of material to be forwarded about the end of July. Thereafter the fortnightly submissions were not evenly maintained from all the farms, and hence all the results from the various places are not strictly comparable.

The tests were made by floating a number of teleutosori in covered watch-glasses of tap water and examining under the microscope after a period of about 18 hours. The results are set out in the accompanying table (Table 1). The sign ++++ indicates that germinations were very abundant. The sign +++ indicates that germinations were plentiful, ++ means that they were scarce, + that they were very rare, and – that they were absent altogether.

It will be seen that material collected from all the centres gave germinations after having been exposed at all the centres. The results obtained from material kept at Bathurst and Cowra were not so good as those from Glen Innes and Grafton. The similarity between the climatic conditions at the two former stations would lead one to look for the similarity which is shown between their results. But the conditions at Glen Innes and Grafton are very different. Glen Innes on the Northern Tablelands experiences severe winters, whilst Grafton on the Coast has very mild conditions. Yet the two sets of material gave closely approximating results. These show an extended period over which germinations occur, when compared with those from Bathurst and Cowra. The drier conditions at the latter stations probably explain this happening.

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Taking next into consideration the source of the material, it is seen that little difference is observable between the rusted straw which had been collected at Glen Innes, Bathurst and Cowra. But the Grafton rust showed a more restricted germination when kept at both Glen Innes and Grafton.

TABLE 1.

Results of tests for viability of teleutospores of *P. graminis tritici* collected in different localities and kept at different places.

Dates of examination for spore germination.	Source of material.			
	Bathurst.	Cowra.	Glen Innes.	Grafton.
	Straw kept at Glen Innes.			
24. 7.22	++++	++++	++++	−
8. 8.22	++++	++++	++++	−
11. 9.22	++++	++++	++++	−
2.10.22	++++	++++	++++	+
11.10.22	++++	++++	++++	+++
25.10.22	++++	++++	++++	−
6.11.22	++++	−	++++	−
23.11.22	−	+	−	−
4.12.22	−	−	−	−
18.12.22	−	−	−	−
	Straw kept at Grafton.			
17. 8.22	−	+++	+++	−
25. 9.22	+++	+++	+++	+++
9.10.22	++++	++++	+++	−
20.10.22	++++	++++	−	+++
6.11.22	+++	+++	−	++
23.11.22	+++	+++	++	+++
4.12.22	+++	++	−	−
18.12.22	−	−	−	−
	Straw kept at Bathurst.			
4. 8.22	++++	++++	++++	
12. 9.22	++++	++++	++++	
26. 9.22	++++	++++	++++	
10.10.22	++++	++++	++++	
25.10.22	−	++++	−	
14.11.22	−	−	−	
30.11.22	−	−	−	
13.12.22	−	−	−	
	Straw kept at Coura.			
3. 8.22	++++	++++	++++	
19. 9.22	++++	++++	++++	
11.10.22	+++	++++	++++	
31.11.22	+++	+++	−	
7.12.22	−	−	−	

As regards the identity of the teleutospore material derived from the various sources, uredospore tests made with rust from Cowra and Grafton in that season showed the presence there of only Form 43. At Glen Innes the rust was Form 46, and at Bathurst a mixture of Forms 43 and 46. The difference in the teleutospore germinations is then not to be correlated with differences in the specialization of the fungus.

An unexpected observation was the germination as early as July. McAlpine (1906) states that teleutospores begin to germinate on warm days about the end of September. But in the July test—the first made—the germinations were abundant.

Another test was made this year with heavily rusted straw sent from Pusa, India. There was not sufficient material for this rust to be included in the series of tests just referred to. When tested on the 15th September germinations occurred, although they were not abundant. A month later the germinations were very abundant. Barberries were inoculated with these as indicated under the heading of "Aecidial Stage".

Results in 1923.

In the succeeding year further tests were made. Wheaten straw showing heavy teleutospore infections was collected at Hawkesbury Agricultural College in December, 1922. The rust present in this plot of wheat was examined in the uredospore stage and only Form 43 was isolated. The rusted straw was kept out in the open on the ground at Hawkesbury Agricultural College by Mr. T. H. Harrison and portions of it submitted from time to time for examination. The first test was made on the 16th April, 1923, and germinations were definite, though not abundant. It had been considered that a mid-April commencement would have been quite early enough to give negative results as a starting point.

After the mid-April germination test, another was made on the 20th May and thereafter they were made at fortnightly intervals. The tests prior to the 3rd July gave negative results in every case, but on that date a few definite germinations were found. The same thing occurred on the 16th July. The test on the 31st July gave numerous germinations, and similar positive results were obtained at fortnightly intervals up to the 9th October. The last batch gave very abundant germinations and was used for an extensive series of barberry inoculations.

The teleutospore germination tests were continued at fortnightly intervals. On the 23rd October no single germination was observed. After such abundant germinations a fortnight previously, this was very striking. Further tests were made at intervals until the end of November with negative results in each case.

The net result of the 1923 teleutospore germination tests was, therefore, that positive results were obtained in April, followed by a period up to July when no germinations were secured, and a further period from July until October when positive results were the rule.

Results in 1924.

In 1924 further germination tests were carried out. Rusted straw was collected at Hawkesbury Agricultural College in December, 1923. In this case it was known that Form 43 was present in the plot from which the material was taken. Fortnightly germination tests were made. Circumstances arose which made it impossible to begin these until 25th June, 1924. Then germinations were sparse, but definite. Similar results were obtained at intervals until September, when they became very abundant. On 17th October they were again sparse. On the 29th October they were rare, and in November and December the results were negative.

Further work was done with teleutospore material derived from other sources in this year. In April, heavily rusted straw of "Little Joss" wheat was received from the State Research Farm, Rutherglen, Victoria. It had been left lying on

the ground since the harvest in December, 1923. In April, germination tests showed that the teleutospores were viable. Cultures from uredospores collected from the same spot in December, 1923, had shown that Form 46 was present.

Another batch of rusted straw was received from Devonport, Tasmania, in March, 1924. Uredospores present in the material gave cultures of Form 46. The straw with its heavy teleutospore infections was exposed to winter conditions and tested at the end of September. The teleutospores were then viable.

Inoculations of barberries were made from both these batches of rust, as described under the heading "Aecidial Stage".

Results in 1925.

In December, 1924, a survey of the rust plot at Hawkesbury Agricultural College revealed the presence of Forms 43, 45 and 46. Six varieties growing in row tests were selected, viz., Bobs, Haynes' Blue Stem, Marquis, Alaska Branched, American Club, and Cleveland. Uredospore tests showed that, in the first three, Form 43 was present, whilst in the last three varieties, the rust present was Form 45. Straw of all six with abundant teleutosori present was saved separately and exposed to weather conditions at Hawkesbury Agricultural College and at Epping, N.S.W. Tests for viability were made periodically. The results are shown in Table 2.

TABLE 2.
Results of germination tests for teleutospore viability in 1925

Dates of Test.	Variety.					
	Bobs.	Haynes' Blue Stem.	Marquis.	Alaska Branched.	American Club.	Cleveland.
	Form.					
	43	43	43	45	45	45
17 March	−	−	+	++	−	−
26 March	++	++	+	++	−	−
17 April	++	−	−	−	−	−
22 April	++	++	−	++	++	+
8 May	++	++	−	++	+	++
21 May	++	+	−	+	−	+
5 June	−	−	+	−	−	−
17 June	−	−	−	−	−	−
3 July	+	−	++	+	−	++
16 July	−	+	−	+	+++	−
31 July	−	++	+	++	−	+++
13 August	−	+	−	+++	−	−
28 August	+++	+++	++	+++	+++	+++
15 September	−	++++	++	++++	++++	++++
8 October	−	++++	+++	++++	++++	++++
28 October	+	++++	++++	++++	++++	++++
5 November	−	++++	++++	++++	++++	++++
19 November	−	−	−	−	−	−
9 December	−	−	−	−	−	−

It will be seen that even as early as the middle of March germinations occurred. This was quite unexpected. No frosts were experienced during the period of exposure, which in the main was hot. Germinations were observed at fortnightly intervals until early November, with one gap at the middle of June. After November there was a sudden failure to germinate. Whilst it is true that the teleutospores germinate throughout so many months, it is evident that the most abundant germinations take place in September and October, i.e., in the spring. The germination capacity shown by Form 43 is not notably different from that shown by Form 45.

Further Results.

Tests in 1926 were made on a small scale. The main aim was to utilize the rust for barberry inoculations. The material used was collected at Sydney University, Grafton, and in Western Australia. This in the uredospore stage was proved to be Forms 43, 45 and 34 respectively. The straw in each case was collected early in 1926 and exposed at Hawkesbury Agricultural College throughout the winter. Tests made at the end of September gave positive results in each case. Further reference to this is made under the heading of "Aecidial Stage".

In 1927 a fairly extensive series of tests was planned with a comprehensive set of teleutospore material representing six physiologic forms. Accidental interference with the frames containing the straw was responsible for the bulk of the material being ruined. The little that was left comprised teleutosori of Forms 34, 44, 45, Indian teleutospores, and *P. graminis avenae* 2. Germinations of all were abundant at the end of September and a little of the material was available for barberry inoculations as reported under the heading "Aecidial Stage". The opportunity of making comparative germination tests, however, was lost.

In 1928 further tests were made with spores of known physiologic forms in order to produce infections on the barberry. When the first test was made on the 6th September good germinations were obtained. The results of this work on the barberry have been reported elsewhere (Waterhouse, 1929).

Summary.

It is clear from these studies that germinations of the teleutospores of *P. graminis tritici* take place much sooner after their formation than was formerly supposed. Whilst September and October are the months when the germinations are most abundant, the spores have been found to give sparse germinations as early as March, continuing thereafter to give somewhat capricious germinations up to the peak period. After November positive results are not to be expected. These results refer to material kept under natural conditions. By utilizing cold storage the range could be widely extended. There has been no notable difference in the germination capacity shown by teleutospores of different physiologic forms.

THE UREDOSPORE STAGES OF P. GRAMINIS AND P. TRITICINA.

There can be no doubt but that this stage is the important one in Australia. It is by means of uredospores that dissemination of rust throughout the crop takes place. Specialization studies involve the use of this stage mainly, although differences between physiologic forms may be discernible in the other stages of the life history. As might be expected then, attention has been devoted mainly to the studies involving this stage.

Specialization Studies.

Historical.

The occurrence of specialization in *Puccinia graminis* Pers. and in other rust fungi has long been known and is a phenomenon of outstanding importance. Dietel (1887) recorded a certain amount of morphological and physiological variation in rust fungi. Eriksson (1894) showed that there was distinct specialization of parasitism in *P. graminis* Pers., and divided the species into five "formae speciales". All produced aecidia on the barberry. Hitchcock and Carleton (1894) in the United States of America obtained results of a confirmatory nature. The fact of specialization in the rusts was still further confirmed by Magnus (1894), Rostrup (1894), Klebahn (1896), Marshall Ward (1901), and others.

Later studies have revealed a much more complex state of specialization. Stakman and Piemeisel (1917) found that *P. graminis tritici* E. & H. was not a simple organism, but that there were at least two strains of it. In 1918 Melchers and Parker (1918) discovered another strain of the rust. Levine and Stakman (1918) in the same year recorded a further strain, and began to make use of certain varieties of wheat as differential hosts to effect a sorting out of the physiologic forms. As early as 1919 these workers had determined twelve distinct physiologic forms of the fungus. Since then the work has progressed to a remarkable degree. A standard technique developed by Stakman and Levine in the United States has been adopted and is being applied in other important wheat-producing countries. The latest announcement from Minnesota shows that fifty-five physiologic forms of *P. graminis tritici* have so far been determined. In Australia it appears that no previous work has been done on this problem. McAlpine (1906) was familiar with the phenomenon of specialization, but reports having had no opportunity of carrying out investigations concerning it.

Present-day methods of investigation have been mainly developed by Stakman and Levine (1922) in dealing with *P. graminis*, and by Mains and Jackson (1926) in the determination of the forms of *P. triticina*. These workers with characteristic courtesy have made available to the writer cultures of their differential hosts, and have thus made it possible to study specialization here in such a manner as to obtain results comparable with theirs.

Method of Determining Physiologic Forms.

To indicate the method that is used, the procedure followed in the case of *P. graminis tritici* may be set out. It has been developed by Stakman and Levine (1922), also Levine (1928), and is briefly as follows. Twelve standard varieties of wheat have been selected as a result of much careful work. They are shown in Table 3.

Grain of these standard differential hosts was kindly supplied in 1921 by Dr. E. C. Stakman and Dr. M. N. Levine, and has since been grown in pure lines for use in the determinative work.

Seedlings to the number of about fifteen are grown in small pots. The first seedling leaf is moistened with water and by means of a flat sterile needle, the uredospores of the rust under examination are placed in this water adherent to the leaf. The pots are then incubated in a saturated atmosphere for 48 hours. They are afterwards placed on well-lighted benches in the plant house to allow the rust to develop. Notes are taken on the rust development twelve to sixteen days later, depending upon the prevailing weather conditions.

TABLE 3.
The set of differential hosts selected by Stakman and Levine for the determination of physiologic forms of *Puccinia graminis tritici* E. & H.

Species of *Triticum*.	Varietal Name.	Cereal Investigation Number.
T. compactum	Little Club	C.I 4066
T. vulgare	Marquis	C.I. 3641
,,	Kanred	C.I. 5146
,,	Kota	C.I. 5878
T. durum	Arnautka	C.I. 4072
,,	Mindum	C.I. 5296
,,	Arnautka (Spelmars)	C.I. 6236
,,	Kubanka	C.I. 2094
,,	Acme	C.I. 5284
T. monococcum	Einkorn	C.I. 2433
T. dicoccum	Vernal Emmer	C.I. 3686
,,	Khapli	C.I. 4013

The types of infection shown by each host are recorded by a simple notation. Arabic numerals from "0" to "4" indicate the order of severity of infection. "0" indicates immunity, and "4" complete susceptibility. Fluctuations between these types are indicated by plus and minus signs. A sixth type is represented by "X". This indicates that a heterogeneous reaction occurs on the one plant. A single leaf may show all classes of reaction ranging from "1" to "4", and further simplification of these reactions is impossible.

The explanation of these symbols is set out hereunder.

Resistant Class.

Type "0". Host immune.—No uredosori are developed, but sharply defined hypersensitive flecks may be present, indicated then as "0;".

Type "1". Host very resistant.—Infection is very light; uredosori are minute and scattered, and surrounded by sharp, continuous, necrotic areas.

Type "2". Host moderately resistant.—Infection is light; uredosori are small to medium in size. Hypersensitive areas in the form of necrotic halos are present. The pustules occur in green, but slightly chlorotic islands.

Susceptible Class.

Type "3". Host relatively susceptible.—Infection is moderate; uredosori are medium in size and show a tendency to coalesce. True hypersensitiveness is absent excepting when cultural conditions are unfavourable.

Type "4". Host completely susceptible.—Infection is normal and heavy. Uredosori are large and generally confluent. Hypersensitiveness is absent excepting when cultural conditions are unfavourable.

Indeterminate Class.

Type "X". Host intermediately susceptible.—Infection is of an heterogeneous nature. Uredosori are very variable and apparently include all types and degrees of infection on the one leaf; no mechanical separation is possible since spores from small and from large uredosori alike produce the same heterogeneous infection.

These classes of reaction are illustrated in Plate xxv.

When the class of reaction on the standard differential hosts has been determined, the results are tabulated. From these tabulated results a dichotomous key has been prepared, and by using this it is easy to determine the physiologic form of the rust under examination.

In the case of the determination of *P. triticina*, a different series of wheat varieties is used, whilst in dealing with *P. graminis avenae*, a particular set of oat varieties has been selected. But in other respects the methods are essentially the same. In taking notes on the reactions given by these rusts, it has, of course, to be remembered that complete susceptibility to *P. triticina* means that a pustule much smaller than that produced by *P. graminis tritici* is found. Similarly in dealing with *P. graminis avenae*, in very susceptible oats the large "4" reaction is commonly surrounded by a somewhat chlorotic area. But in the main the same system of note-taking holds.

Purity of Differential Hosts.

Attempts to grow rust fungi on artificial media have so far failed. The only method of cultivating them is to make use of living host-plants. Were it possible to utilize synthetic media, the rust problem would be greatly simplified.

Variation amongst living organisms is universal. To determine the variation—specialization—within the fungus causing stem rust, living host-plants must be used. These in turn are subject to variation. The extent of this variation it is important to investigate. The twelve varieties have already been enumerated. It is clear that if the determination of physiologic forms by this means is to be effected and the results are to be comparative, every care must be exercised in order to keep the differentials pure and true to name.

The need for this became apparent early in the studies. These have been possible only through the courtesy of Dr. Stakman and Dr. Levine in supplying grain of their standard differentials. It was expressly stated that in certain cases the sample given was known not to be pure. Results obtained with this grain prior to its being multiplied in Australia indicated that this was the case, and single plant selection has been practised from the beginning of the studies in 1921. Studies were made of some of the aberrant types.

The results of some of these studies of the variation shown by the differentials are of interest.

Arnautka.—Grain of this variety as received from Minnesota was observed to give seedling reactions which were sometimes abnormal. Pots of seedlings inoculated with Form 43, known normally to produce flecks on Arnautka, gave occasional plants, varying from 2% to 5% of those tested, which showed a fully susceptible reaction.

In 1926, six seedlings derived from Minnesota-grown grain and showing the characteristic flecks produced by Form 43, were transplanted to an open bed and grown to maturity. At the same time, four showing the aberrant "4" type of reaction were similarly taken. At maturity, all the resistant plants were of the "Arnautka" type, as were three of the four susceptibles. But the fourth plant proved to be a "vulgare" wheat conforming to *Triticum vulgare erythrospermum* Körn. Clearly admixture of foreign grain with that of "Arnautka" had taken place.

In 1927, grain derived from each of the ten plants was sown and tested with Form 43 before the seedlings were transplanted to the open and grown to maturity. The progeny of the six resistant plants all gave resistant seedlings, whilst those of the four susceptibles gave all susceptible seedlings. At maturity a number of random selections, varying from three to six, were made from each family.

In 1928, the seedlings of the selections were again tested with Form 43, with the confirmatory result that progeny of the resistant plants were resistant, and those of the susceptibles were susceptible.

A scrutiny of the susceptible durums in these tests failed to reveal any morphological or marked cultural differences between them and the normal Arnautka types. Whilst the mixing of grain of a "vulgare" wheat with that of Arnautka could be readily discerned and corrected, the occurrence of two apparently identical types showing susceptibility in one case and resistance in the other might well lead to confusion and error in the results.

Mindum.—A state of affairs similar to that reported for Arnautka was found to occur with Mindum, and was also studied. In 1926 three seedlings derived from Minnesota grain which showed the expected flecking with Form 43 were grown to maturity, as were also two which showed a "3" type of reaction. The latter proved to be "vulgare" wheats again conforming to *T. vulgare erythrospermum* Körn. Tests in 1927 of progeny of all five families showed that they bred true for their rust reaction, and this result was confirmed by a comprehensive series of tests in 1928 made with further random selections in each of the families.

In this case the aberrant results were due to impurity of the grain.

Kanred.—In the earliest studies made with grain kindly provided in 1921 by Dr. E. C. Stakman, as well as those in later years when grain was forwarded by Dr. M. N. Levine, departures from the normal reaction on this host were noted. For example, pots of twelve seedlings inoculated with Form 43 frequently showed that eleven were completely immune, and one completely susceptible. Summation of a number of these results shows a frequency of from 5% to 8% of these susceptible plants. Inoculation of a fresh pot of Kanred with inoculum from a susceptible Kanred would give a similar result, practically all the seedlings being immune.

A study was commenced in 1926 with grain received from Minnesota in that year. Eleven plants conforming to the Kanred type at maturity were taken at random, and progeny of each was tested with Forms 33, 43 and 46. Kanred normally is susceptible to Form 33 and immune to Forms 43 and 46. The grain of each of the eleven plants was divided into three portions which were sown in pots for the seedling tests. The results showed that there were three classes of families. In the first class there were six families which each showed susceptibility represented by a "3" reaction to Form 33, and immunity (no reaction whatever) to Forms 43 and 46. In the second there were three families which showed the susceptible reaction known as "3" to Form 33 and the moderately resistant "2" type of reaction to Forms 43 and 46. In the third class, there were two families which were each susceptible to Form 33 and also susceptible to Forms 43 and 46, giving a "3" reaction throughout. These seedling results were borne out by field observations. At Hawkesbury Agricultural College where Minnesota-grown grain of Kanred was sown and where Forms 43 and 46 were present, it was observed that the majority of the Kanred plants were quite free of rust, but occasional plants showed a severe attack of stem rust. Form 33 is a

culture which is being kept under control in the plant house, not having occurred naturally in Australia.

In 1927 three out of the six families belonging to the first class were taken at random and the rest discarded. From each of these three families, as well as from the three families belonging to the second class and from the two belonging to the third class, ten single plants were taken and their progeny subjected to seedling tests with the three rust forms. In all cases they bred true to their class reaction. The only departure from a normal state of affairs occurred in one of the ten plant progenies belonging to the third class, where two seedlings from a pot of fifteen revealed the "grass tuft" habit. Further studies concerning this occurrence are in progress.

In 1928 further pedigree tests with forty-one progenies of plants from each of the three classes were made. Again it was found that the seedling reactions were true to their class.

In 1929 a still further generation was tested, comprising families from each of the three classes. The reactions given were characteristic of the respective classes.

In Kanred, therefore, there was a mixture of strains indistinguishable morphologically, but showing wide divergence in their rust reactions.

Kubanka.—The case of this differential has been complicated by reason of the effect which altered environmental conditions apparently have upon the host-parasite relationship. In the earlier days of the investigation, before this effect was recognized and when attempts were being made to sort out pure lines of the variety, considerable difficulty was met with.

As far back as 1921, seedling results with grain kindly supplied by Dr. Stakman showed the mixed results similar to those already described for other differentials. At the harvest of 1922, eight apparently identical single plants were selected, and have been grown in pure lines since. A very great number of tests have been made from time to time with these selections.

From the outset, marked differences were shown between the eight families. Thus in 1923, the reactions given by Form 27 were of the "4" type with one of the families and of "0;" type with another. An exact reversal of these reactions was given when these same two families were tested with Form 46. That is to say, the reaction on Kubanka given by each of these forms might have been listed as completely susceptible or completely resistant, depending upon the particular strain used in the test. This sort of divergent result was obtained in an extensive series of tests which utilized fifty-five different rust cultures representing six different stock physiologic forms.

In following years tests have been extended and show clearly that the eight plants taken at random in 1922 were not all genetically alike as regards rust resistance, although all appear to conform to the Kubanka type. They are divisible into three groups on the basis of the reactions shown in a series of tests made simultaneously under summer conditions to Forms 43 and 46. Five of the eight were susceptible to 43 and resistant to 46, one was resistant to 43 but susceptible to 46, and two were susceptible to both these forms. Further references to these results are made in the consideration of variations induced by environmental changes.

Other strains of Kubanka derived from other sources were also subjected to test. For example, grain of Kubanka C.I.2094, received from Dr. M. N. Levine in

1926, behaved like the first group of five families listed above, as did also grain of "Kubanka C.I.8". Grain of "Kubanka C.I.10" gave results similar to those of the second group. Grain of "Kubanka" supplied by Mr. J. T. Pridham, of Cowra, showed under summer conditions that the seedlings were equally susceptible to every one of the ten physiologic forms which were available for test.

The urgent necessity for scrupulous care in maintaining the same pure lines if work at different centres is to be comparative is clearly brought out in this work with Kubanka.

Occurrence of Natural Crosses.

Natural crossing in pedigree families may occur and seriously complicate results. Several cases have come to light.

In a row test of "Indian 12" at the University of Sydney, two natural crosses occurred. The grain used for sowing came from a single ear of a typical plant grown at Hawkesbury Agricultural College in 1924. In the row test were noted two plants which were not fully bearded, but showed only tip-beards. Each was saved and its grain sown the following year. The progeny varied in regard to beard, showing gradations between slight tip-beard and full beard. There was also segregation for the smooth chaff and velvet chaff. There is little doubt but that natural crossing of "Indian 12" had occurred at Hawkesbury Agricultural College in 1924.

Another case dealt with a variety of *Triticum sphaerococcum* Perc. In 1924 several ears of two varieties of this wheat were sent from Cambridge, England, by Mr. F. T. Brooks. The grain of one of these ears was rubbed out and sown at the University of Sydney in a row test. One of the resultant plants was markedly different from the type, being a "vulgare" wheat with a tip-beard. This was saved and its grain sown the next year. Segregation occurred in regard to a number of characters, as illustrated on Plate xxiv. Clearly in this case the natural cross had occurred at Cambridge.

An instance in oats was very striking. Grain of "Richland" grown at Cowra in 1926, was sown at Hawkesbury Agricultural College the following year. A number of single plants were harvested. One of them had grain larger than the normal "Richland" grain. A box of it was sown and the seedlings tested with *P. graminis avenae* 1. This form gives a resistant reaction on "Richland". The test showed 103 resistant and 41 susceptible plants. This is a near approach to a 3 : 1 ratio, and indicates that probably at Cowra a natural cross between "Richland" and a susceptible variety like "Algerian" had taken place.

The Effect of Varying Environmental Conditions in the Plant House upon Rust Development.

The technique employed in the determination of physiologic forms has already been referred to (page 628 *et seq.*) and the statement made that after inoculation the pots of seedlings are placed on well lighted benches in the plant house to allow the rust to develop. Under the conditions which prevail in some seasons in the United States, sunlight is lacking. In New South Wales the opposite is often the case. Here there are wide divergences between the conditions in the plant house under winter as compared with summer conditions. The differences in the temperatures are very considerable. Evidence has accumulated which shows that such a difference in the environmental conditions may profoundly affect the rust reaction upon particular hosts. Since the form determination is based upon the host reaction, this matter is of extreme importance.

It is unfortunate that no temperature control apparatus has so far been available for these studies. It has, therefore, only been possible to take advantage of the variations in the plant-house conditions which have been induced by seasonal changes. The tests made have practically involved a comparison of results obtained under winter conditions with those found under summer conditions. In the early stages of the work, this variation in the results obtained was not recognized, with the consequence that a number of contradictory results were obtained which were not then intelligible. So much evidence has now accumulated, that it is quite clear that determinative work must be done with a narrow range of fluctuation in the environmental conditions if the results are to have a value for comparative purposes. If it be remembered that the type of reaction which is taken note of in the determinative work is a measure of the host-parasite relationship, it is not surprising that the balance existing between the two should be liable to variation as environmental conditions change. It is not possible at this juncture to indicate the extent to which fluctuations in the specific environmental factors such as temperature and light bring about an alteration in the reactions, or of the degree of the response made by the host and by the parasite to these fluctuations. That marked effects in the rust reactions are induced will be seen to be indisputable.

Material and Methods.

A comprehensive series of tests was made to provide information regarding the behaviour of the Australian forms, as well as a comparison of their reactions with those of other valuable forms under varying environmental conditions. The following forms were used in the tests:

Form 16.—This was derived from aecidial infections of the barberry produced by inoculation with teleutospore material on wheat straw received from Pusa, India, in April, 1927.

Form 27.—This had its origin in aecidial infection of a barberry produced by inoculation with teleutospores on wheat straw received from Milton, Wales, in May, 1923, from Miss K. Sampson of Aberystwyth and Mr. A. D. Cotton of Kew.

Form 33.—This form was supplied in the uredospore stage by Dr. M. N. Levine in 1922.

Forms 34, 43, 44, 45, 46, 54, 55.—These were all obtained from collections of uredospore material made at different times from various localities in Australia.

Throughout the series of tests, the same culture of each of the forms was used. In no case was it a monosporous culture, but its reactions on the differential hosts were repeatedly checked. Of Form 45 two distinct cultures were used throughout. One reason was that one of them which originated from aecidiospores and is designated Form 45A, has always given a "2" reaction on "Kanred", whereas all other cultures of Form 45 have given a "0" reaction, and a search was being made to find a wheat which would serve as a wider differential of this culture.

These forms were tested on a number of the differential hosts. The results are described separately under the headings of these hosts.

Kubanka.

Reference has already been made to difficulties encountered with Kubanka as a differential, and to the fact that a series of single plant selections was made of

several strains of this variety in founding pure lines. Tests made simultaneously with the one form on certain of these pure lines showed conclusively that there was extreme genetic diversity as regards rust resistance. A good deal of work was done in testing these pure lines in their reactions to known physiologic forms under varying environmental conditions, with interesting results.

The strains of Kubanka used were as follows:

"Kubanka No. 1" to "Kubanka No. 8".—These eight strains had their origin in grain labelled "Kubanka C.I. 2094" kindly supplied by Dr. E. C. Stakman in 1921. This grain was sown in a small plot at the University of Sydney and at the harvest of 1922 eight single plants were taken at random and have since been grown in pure lines.

"Kubanka 2094".—This line had its origin in a sample of grain sent by the Bureau of Plant Industry of the United States Department of Agriculture in 1919. From a row of it a random selection was made of a typical plant growing at Hawkesbury Agricultural College. It has since been grown as a pure line.

"Kubanka Minn".—This line came from grain of "Kubanka C.I. 2094" kindly supplied by Dr. M. N. Levine in 1926, and since grown in pure line.

"Kubanka C.I. 8".—The history of this is the same as that of "Kubanka 2094".

"Kubanka C.I. 10".—This line came from grain supplied by Dr. E. C. Stakman under this name.

"Kubanka Cowra".—In 1922 Mr. J. T. Pridham, of Cowra Experiment Farm, supplied grain which has since been pure lined. This strain has heads which are rather more compact than those of "Kubanka C.I. 2094", and is a rather heavier grain yielder under conditions prevailing at the University of Sydney and Hawkesbury Agricultural College.

There were, therefore, thirteen strains available for testing.

In the years 1924 to 1927 a number of tests were made with these strains at different times. Using the identical cultures which have been used throughout the studies to represent the particular forms, inoculations were made from time to time. The results were not identical. To illustrate the sort of variation found, the results obtained on "Kubanka 1" are set out in the following table.

TABLE 4.

Reactions produced as a result of inoculating "Kubanka 1" with certain forms of *P. graminis tritici* at different seasons.

Form No.	Date of Inoculation.				
	October, 1924.	October, 1925.	March, 1926.	May, 1926.	May, 1927.
27	4	2	3	3	3
33	3	;	X	;	;
34			3	; & 1	;
43	X	X	X	;	;
45		2+	X	3	3
46	2+	1+	2	2	2
55	X	X	3[c]	X	3+

It will be seen that a good deal of variation is shown in the reactions given by the same form in these tests. Uniformity in the results is lacking. But there are indications that the susceptibility is greater in those tests made in the hotter months.

Other tests utilizing others of the strains of Kubanka gave results which were essentially similar.

To investigate this variation better in the reactions a more complete and comparative series of tests was carried out. The tests were made in pairs and were performed twice. For the first pair, a single plant of each of thirteen pure lines of Kubanka was used. Half of its grain was used for the "summer test", made in February, 1928, and the balance in the "winter test", made in June, 1928. For the second pair of tests, another single plant of each line was used, half the grain being used in the "winter test" made in July, 1928, and the remainder of the grain from the same plant used in the "summer test" made in January, 1929. An exception occurs with Form 11, and "New Form", which were tested in January, 1929, and July, 1929, not having been available earlier.

In all cases, every precaution was taken to ensure that the inoculum used was what it purported to be. Prior to the test a form determination on the standard differentials was made to ensure that no contamination of the culture had taken place. The inoculum used was taken from an appropriate susceptible host. All the inoculations of any particular test were made on the same day and the pots of seedlings treated in the same way. The best possible conditions of light were given, all the pots being placed on a northern bench of the plant house. Note-taking on each test was done on the one day when the reactions were fully developed and the results checked two days later.

Table 5 sets out the results:

TABLE 5.

Means of reactions on certain strains of Kubanka given by physiologic forms of

Form No.	Kubanka 1.				Kubanka 2.				Kubanka 3.				Kubanka 4.				Kubanka 5.				Kubanka 6.			
	Test.				Test.				Test.				Test.				Test.				Test.			
	1st.		2nd.		1st.		2nd.		1st.		2nd.		1st.		2nd.		1st.		2nd.		1st.		2nd.	
	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.
11			3+	;			4	3+			3	;			3+	;			3+	;			3+	;
16	4	X	4	4	4	3	4	3	3	X	4	3	3	3	4	3	4	X	4	3	4	X	4	X
27	4c	X	4	X	;	2≡	1=	1=	4c	X	4	3	4c	X	4c	X	4c	X	4	X	4	3	4	3
33	3	;	3	;	2	2=	2=	2	X	;	X	;	X	;	X	;	X	;	4	;	3	;	3	;
34	3	;	3	1	3+	3	3	4	3+	;	3+	;	X	;	3+	;	3+	;	4	;	3	;	3+	;
43	X−	;	3+	;	;	2=	;	2	3	;	3	;	3	;	3	;	X	;	3+	;	X	;	3+	;
44	4	;	3+	;	1	2=	;	2−	X	;	3+	;	X	;	3+	;	X	;	3+	;	X	;	3+	;
45	X+	X	X	X	4	X	4	4	X+	X	3	3	X	X+	X	X	4	X	4	X	X	X	X‡	X
46	1	2=	1−	2	4	X	4	3	1	2=	1	2	1	2	1=	2−	4	X	4	X	1+	2=	1=	2=
54	3	;	3+	;	2−	2=	2−	2	X	;	3	;	X	;	3+	;	X−	;	3	;	X	;	3	;
55	X	X	X+	X	4	X	4	4	X	3+	3	3	X	X+	X	X	4	X	4	X	X+	X	X+	X
New Form			3	;			;	;			3	;			3	;			3	;			3	;

The results show clearly that there is great genetic diversity between the strains of Kubanka as judged by their rust reactions. There are numerous indications of this. For example, consider the reactions to Form 46 given in the first of the series of tests, viz., Summer, 1928. Kubanka 1 gives "1", Kubanka 2 gives "4", and Kubanka 5 gives "4". Form 27, in the same test, gives on the same Kubanka 1 "4c", on Kubanka 2 it gives flecks, and on Kubanka 5 it gives "4c".

The thirteen strains seem to fall into three groups, within which the members somewhat closely resemble each other.

Group 1.—Eight of the strains behave, in the main, in the same way. They are Kubanka 1, 3, 4, 6, 8, 2094, Minn., and C.I. 8. It is believed that this group represents the true Kubanka strain as used in the determinative work. It is bulk grain of the Kubanka Minn. which is used as the Kubanka standard in the determinative work on the physiologic forms. Tests made with this bulk grain have given results similar to those of Group 1.

Group 2.—There are three of the strains which appear to be related, viz., Kubanka 5, Kubanka 7, and Kubanka Cowra. All ten forms give reactions which in general agree on these strains.

Group 3.—The remaining two strains, viz., Kubanka 2 and Kubanka C.I. 10, show resemblances to each other. It was unfortunate that through an error the latter was omitted in the second series and only one year's comparative tests were made with Kubanka C.I. 10. But on this basis there is a general agreement between the two strains.

The agreement between the two summer and the two winter reactions is not absolute. In most cases the disagreement is slight. Again it is pointed out that

Puccinia graminis tritici when tested under different environmental conditions.

Kubanka 7.				Kubanka 8.				Kubanka 2094.				Kubanka Minn.				Kubanka C.I. 8.				Kubanka C.I. 10.				Kubanka Cowra.			
Test.				Test.				Test.				Test.				Test.				Test.				Test.			
1st.		2nd.		1st.		2nd.		1st.		2nd.		1st.		2nd.		1st.		2nd.		1st.		2nd.		1st.		2nd.	
Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.
		3+	;			3	;			3+	;			3	;			3	;			3	3			3+	;
4	3	4	3	3	3	3	3=	3	X	4	3	3	X	4	3	X+	X	3	3	4	4			4	3+	4	3
4	X	4	3	4c	3	4	3	4c	X	4	3	4c	3	4	X	4c	3	4	3	;	;			4	3	4	3
X+	;	4	;	X	;	3	;	X	;	3	;	X	;	3	;	X+	;	3	;	;	;			3	;	4	;
4	;	3+	;	3	;	3	;	3	;	3	;	3	;	3	;	3	;	3+	;	X	;			4	;	4	;
X	;	3+	;	X	;	3+	;	X	;	3+	;	X	;	3	;	X	;	3+	;	;	;			3	;	4	;
X+	;	3+	;	X+	;	3+	;	X	;	3+	;	3	;	3+	;	3	;	3+	;	;	;			4	;	4	;
4	X	4	3	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	3	4	4			4	3+	4	3c
4	X+	4	3	1	2=	1=	2	1	2=	;	2−	;	2=	1=	2−	1	2=	;	2−	4	4			4	3+	4	3
X−	;	3	;	X	;	3+	;	X	;	3+	;	X+	;	3+	;	3	;	3+	;	;	;			X	;	3	;
4	X	4	3+	X	X	X+	X	X	X	X+	X	X	X	3	X	X	X	3	3	4	4			4	3+	4	3c
		3	;			3	;			3	;			3	;			3	;			3	;			3	;

differences in the conditions prevailing in the plant house may conduce to this lack of agreement. In addition, the conditions prevailing at the times when the two summer tests were made were not identical, nor were they when the two winter tests were carried out. Higher temperatures prevailed in the summer test of 1929 than in the 1928 test. But in the main, there is a similarity between the two series of tests.

Within these three groups certain variations occur. Exact agreement is hardly to be expected. Major variations between the summer and winter reactions are shown in many cases. Thus Form 33 on Kubanka 1, gives "3" in the summer and "0;" in the winter. From other tests made during spring and autumn, evidence is available that intermediate reactions are to be expected then. In the plant house, particularly where a large series of tests is in progress at the one time, it is not possible to arrange all the pots of seedlings so that every one shall be under exactly the same environmental conditions. For example, the degree of lighting and the amount of heat received from the sun vary considerably. This may result in a certain variation in the reaction shown. Only when adequate control apparatus is available can this point conclusively be cleared up. But within certain limits of variation the massing into the three groups would seem to be valid.

It is clear that certain forms show a much more marked variation between the summer and winter reactions than do others. Thus, Forms 16, 27, 45, 46 and 55 do not exhibit a very marked difference between the summer and the winter reactions. On the other hand, Forms 33, 34, 43, 44 and 54 show, in most cases, a marked contrast between the reactions given under the two sets of conditions. This means that in the first case the host-parasite complex is not markedly affected by the range of seasonal variation, whereas in the second case it is. It is to be emphasized that evidence is brought forward under other headings to support the contention that Forms 43, 44 and 54 are rather closely related, as are also Forms 45, 46 and 55.

Acme.

From the grain received from Minnesota in 1921, four typical plants were selected at random in 1922 when the Kubanka selections were made. Under the names Acme X, Acme 1, 2 and 3, they were pure lined. From the further supply of grain received from Dr. Levine in 1926, a further selection was made and designated "Acme Minn.". A series of tests similar to those made with the selections of Kubanka was conducted with the same cultures on these five strains of Acme at the same times that the Kubanka tests were carried out.

The results are set out in Table 6.

It will be seen that the variation that occurs between the strains is very slight. The difference between the summer and winter reactions is much less than in the case of Kubanka. Some of the forms do show a variation. This is notable in the case of Form 43 and Form 54, where the change from "3+" in the summer to a fleck in the winter is extreme.

Marquis.

When the series of tests were in progress with the selections of Kubanka and Acme, a pure line of Marquis was also included. In previous work there was evidence that changes occurred in the reactions given on this host. The strain

TABLE 6.

Means of reactions on certain strains of Acme given by physiologic forms of *Puccinia graminis tritici* when tested under different environmental conditions.

Form No.	Acme X.				Acme 1.				Acme 2.				Acme 3.				Acme Minn.			
	Test.				Test.				Test.				Test.				Test.			
	1st.		2nd.		1st.		2nd.		1st.		2nd.		1st.		2nd.		1st.		2nd.	
	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.
11			3	X−			3	X=			3	X=			3	X=			3	X=
16	3	3	4	3	3	3	4	3	3	3	4	3	3	3	3	3	4	3	4	3
27	X‡	3	3+	3	4	X	4	3	4	3	4	3c	4	3	4	3	4	3	4	3
33	3	3c	3	X	3	3	3	3	3	3	3	3	3	X	3	3c	X	3	3	3c
34	X	3c	3	X	3+	X	3	3	X+	X	3	X	X+	X	3	X	3+	X	3	3
43	X−	;	3+	;	X−	;	3+	;	X−	;	3−	;	X	;	3+	;	X−	;	3	;
44	3	X	3+	X	4	X	3+	X	4	X	3+	X	X+	X	3+	X	3	X	3	X
45	X	X	X−	X−	X	X−	3c	X−	X	X	X	X	X	X	X	X	X	X	X	X
46	1	2−	1−	2−	1	2=	1	2−	1	2=	1	2−	1	2=	1	2−	1	2=	;	2−
54	X+	X−	3	X	4	X	3+	X−	4	X−	3+	X−	3	X=	3+	X−	X	X=	3+	X−
55	X	X	X	X	X	X	X	X	X+	X	X	X	X	X	X	X	X	X	X	X
New Form			3	1+			3	1			3	1			3	1			3	1

used came from a single plant selected in 1922 from grain supplied by Dr. Stakman.

The results are shown in Table 7.

Again it is seen that marked variations occur in the reactions given by certain forms under summer as compared with winter conditions. This is notable in the case of Forms 46 and 55, in which an extreme range of variation occurs. A change from a "4" to a "2−", or from a "4+" to an "X=" reaction is one of major importance and again liable to be very upsetting in determinative work. Thus, Form 55 is separated from Form 45 on the basis of the reactions on Marquis; this host gives "4" with the former and "2" with the latter. That there is a distinct difference between these forms is shown by other tests elsewhere reported.

There is evidence that intermediate degrees of resistance (or susceptibility) may be shown under the intermediate environmental conditions prevailing between summer and winter.

Thus, in a test made in February, 1928, it was found that five cultures of Form 45—including the stock culture used throughout the work—were giving an "X" reaction on some Marquis plants in addition to a "3+" reaction on other plants in the same pots. In each case, from the "X" reactions cultures were started from the "2" and from the "3+" pustules on the same leaves, as well as cultures from the straight-out "3+" reactions. From these fifteen cultures on

TABLE 7.
Means of reactions on a pure line of Marquis given by physiologic forms of *Puccinia graminis tritici* when tested under different environmental conditions.

Form No.	Marquis I.			
	Test.			
	1st.		2nd.	
	Summer.	Winter.	Summer.	Winter.
11			3+	X−
16	2	2−	3c	2
27	2++	2	4c	2
33	2+	1	3	2=
34	4	3	3+	3
43	3	3	3	3
44	3+	3	4	4
45	2	2=	2++	2
46	4	2−	4+	2
54	4−	3	4	3
55	4	2	4+	X=
New Form			3+	2

Federation, comparative tests on the standard differential sets were made in April. The form in each case was Form 45, the reactions of Marquis varying from "1=" to "2". The stock culture of Form 55 was included in this test for comparative purposes. It gave the typical reactions, including the "4" on Marquis.

Variation in Form 34 on Durum Differentials.

Further evidence of extreme variability in the rust reactions on account of altered environment is available in connection with Form 34. This form was first found in Western Australia in 1925. The next year it occurred in New South Wales and since then has been the predominant form in Australia. Changes in its reactions on three of the durum differentials have again and again taken place. In the summer the normal susceptible reactions which are listed for 34 are given. But in the winter, an entirely different set of resistant reactions is obtained. When these winter reactions were first observed it was considered that a different form was concerned. They occurred so frequently that the reactions were listed and forwarded to Dr. Stakman, who allocated a number to the form. It is now known that it was Form 34, and that transitions between the two occur.

The first case occurred in an isolation from wheaten straw collected at Bathurst. This was tested in the usual way in April, 1927. Variation from the normal reaction given by Form 34 was shown on the durums. Instead of

susceptible reactions throughout, the results were Arnautka "4", Mindum "0;", Spelmars "0;", Kubanka "X", and Acme "3". A repetition using inoculum from Little Club gave the same result, excepting that there was now only one Arnautka plant in the pot which showed a "4" reaction, whilst three others showed flecks. A further test was made, the result being the production of flecks on Arnautka, Mindum and Spelmars, "X" on Kubanka, and "3" or sometimes "X" on Acme. Three further sets of differentials were inoculated from different hosts in August and again the same resistant series of reactions was given. The culture was kept by subculturing on Federation until January, 1928, when it was cultured on the set of differentials. It gave the susceptible reactions on the durums characteristic of Form 34. In March, 1928, the same normal Form 34 reactions were shown. In May, 1928, the durums again gave the resistant reactions. Illustrations are shown on Plate xxv.

Another culture from material collected at Wagga came up for test in June, 1927. It gave the resistant reactions on the three durums. Inoculum from six of the hosts, viz., Little Club, Marquis, Kanred, Kota, Kubanka and Acme, was used to inoculate six further sets. In all cases the result was the same. Three of these subcultures were used early in September on three further sets of differentials, and again the resistant reactions were shown. At the end of November these cultures were again used to inoculate sets. This time the normal susceptible reactions for 34 were given.

Eight other newly received isolations from various localities were dealt with in the same way and gave the same result.

One of the two stock cultures which had been obtained in 1925 and since kept in culture was placed on a set in June, 1927. The resistant reactions were shown on the durums.

The principal stock culture of Form 34, which had been isolated in December, 1925, and had since been used in repeated tests, was tested in the same way. In June, 1927, the resistant reactions were given. In October, 1927, two tests gave the susceptible reactions. The same result was obtained in January and March, 1928. On 24th April one set was inoculated and kept in the warmer and sunnier plant house, and another set treated in the same way was kept in the cooler and shadier plant house. In the former, the reactions varied in the pots of durum seedlings. A typical result from a pot of sixteen seedlings was that five showed "4", six showed a mixture of "3", "2" and flecks, and four showed flecks only. In the set kept under the cooler conditions no case of simple "4" reactions occurred on the durums. On the same leaf were found flecks, "2" and "3" reactions, the latter occurring much less frequently than the flecks and "2" reactions.

Another pair of sets was inoculated and incubated under the same conditions. In the warmer situation, the mixture of flecks, "2" and a few "3" reactions on the same leaves was shown. In the cooler position only flecks occurred.

On 28th May two further sets were treated in the same way. In both cases only flecks were shown. The next inoculation made on 2nd July, gave the mixture of "0;", "2", and "3" in the warm situation, and flecks in the cool place. An inoculation on 22nd August gave the same result. On the 10th September the results were some simple "4" reactions, and others with the mixture of "0;", "2" and "3" in the warm situation, and only "0;", "2" and "3" in the cool location.

On the 8th October the result was the normal "34" susceptibility in the warm situation, whilst in the cooler house there were "4" reactions on some leaves and the mixture of "0;", "2" and "3" on other leaves in the pots. In December, 1928, the normal "34" reactions were given in both locations.

It is clear that the same culture showed considerable variation in its reaction, depending upon its environment. The transition was followed from susceptibility to resistance and back to susceptibility.

Lacking the temperature control facilities, another method of attack was followed. Early in January, 1928, a large amount of heavily-rusted wheat straw and a second batch of similar barley straw, both in a green condition, were collected at Hawkesbury Agricultural College from two plots which had repeatedly shown the presence of only Form 34. The straw was cut into short lengths and allowed to dry out partially during two days' exposure in the laboratory. Each batch was then divided into twenty-five equal packets of rusted straw. One of each was used to inoculate a set of differentials. The other packets, thanks to the courtesy of Peters' American Delicacy Co., Ltd., were kept in their ice-house. At intervals of about a fortnight a packet of the wheaten and one of the barley straw were withdrawn. Inoculum from the straw was scraped into specimen-tubes containing distilled water, and the mixture of spores transferred to the moistened leaves of the differential hosts directly up to the set used on the 17th April. Thereafter, owing to lessened viability, it was inoculated on to large pots of Federation seedlings and thence on to the sets of differentials.

The initial inoculation made on the 4th January gave, in each case, the normal "34" reactions. Each of these cultures has been kept alive since by sub-culturing on Federation. An inoculation of sets made on 25th June, 1928, gave from each the resistant reactions on the durums. Tested again in November, 1928, they gave the complete susceptibility.

Withdrawals made 24th January, 11th and 27th February, 15th March and 2nd April, gave the normal susceptibility on the durums. The set inoculated on the 17th April gave the mixture of "0;", "2" and "3" reactions on the same leaf. Inoculum from the next withdrawal, made on the 30th April, was not available in sufficient quantity for a set until 6th June. It then gave only "0;" on the durums. The same applied to withdrawals made on the 14th and 28th May and 11th June. Withdrawals on the 26th June and 9th July gave inoculum for sets on the 13th August, and in both cases gave the "4" reaction on some leaves, and the "0;", "2" and "3" reactions on others in the same pots. Both of these particular cultures were again put on to sets in November and gave the fully susceptible reactions. Further withdrawals, made on the 23rd July, 6th and the 23rd August, and 4th September, failed to give any infections of the Federation seedlings. But it was considered very satisfactory to have kept the uredospores in this viable condition for six months.

This test showed clearly that the normal susceptible reactions given by Form 34 on the durums alter during the winter months to resistant types.

Another test was made. This time a batch of heavily-rusted wheat straw was obtained from Cowra in July, 1928, from an area where only Form 34 had been determined. It was made up into equal packets which were stored in the ice-house and tested at intervals.

The initial test made on the 30th July gave only flecks on the three durums. This initial culture was kept until November, 1928, and again put on the set. It gave complete susceptibility on the three durums. On the 23rd August and 4th September there were "0;", "2" and "3" reactions. On the 24th September some leaves showed "4", others the mixture of "0;", "2" and "3". Withdrawals were made on the 2nd, 16th and 30th October, and 13th and 27th November. They gave the complete susceptibility. Further withdrawals on 11th and 27th December, 1928, failed to give any infections.

This series of tests showed that the material from which the resistant reactions were obtained during the winter gave the susceptible type during the summer.

Apart from this significant variation in the reactions on the durum varieties, some difference was discernible on the other differentials. On Little Club, Marquis, Kanred and Kota, the summer reactions of "4+", "4–", "4", and "4=" became respectively "3+", "3", "3–", and "3–". On Einkorn and Khapli, the summer reactions of "1=" in each case became "1+++" in each case. Vernal Emmer showed no appreciable change. Variation of this order has little significance.

Variation in Federation and Khapli.

Form 46 has been in culture since 1924 and has been repeatedly tested on the differential sets. That alterations occur in the reactions given on Kubanka and Acme when summer and winter tests are compared, has already been shown. A further striking variation has repeatedly been noted.

For the purpose of subculturing the various wheat stem rusts, Federation seedlings are used. On them the reaction given by Form 46 during the warmer part of the year is "4++". During the winter this falls to a reaction approximating to a "1++". That is to say, very small isolated uredosori occur on highly chlorotic and somewhat necrotic areas. In the winter of 1927, when this weakening in the reaction on Federation was overlooked, three subsidiary cultures of 46 were lost through an insufficiency of inoculum for subculturing.

It has been noticeable that Form 27, which was obtained from teleutospores collected in Wales, behaves in the same way, giving a very weak reaction on Federation during the winter. Just the opposite has frequently occurred on Khapli. On this host, the summer reaction is a very sharp "1". But on many occasions in the late autumn and the early spring, the reaction has been a "4". It was thought that this might have been due to the grain used being something other than true Khapli. Such "susceptible" plants grown to maturity have, however, been typical of Khapli, and have given grain which in the summer seedling tests has been quite resistant. Illustrations of these Khapli reactions are shown on Plate xxvi.

Effect of Seasonal Variation in the Plant House upon Reactions of P. graminis avenae *on Oat Seedlings.*

Single plants of "Joanette", "White Tartar", and of "Richland" oats were taken. Part of the grain was tested under summer conditions (February, 1928) and part of the same grain tested under winter conditions (June, 1928). Two different cultures of each of the three forms available were used. The results were as follows:

Form No.	Joanette.		White Tartar.		Richland.	
	Summer.	Winter.	Summer.	Winter.	Summer.	Winter.
1	3+	0;	2++	2−	2+	2=
2	3+	3	2++	2−	2+	2=
7	3+	3	4	4	2+	2

It will be seen that the only significant change took place in Form 1. Here a complete change on Joanette is shown from susceptibility in the summer to resistance in the winter. A differentiation between Forms 1 and 2 under summer conditions is therefore impossible.

Several cultures of this Form 1 have shown on Joanette a very definite "X" reaction in spring and autumn tests. Isolations have been made from "1" pustules occurring in the "X" reaction and also from the "3" pustules, and these cultures compared later under summer and winter conditions. The results have been, from each, the "3+" in summer and the "0;" in winter. Illustrations are given on Plate xxvi.

A further test was made to confirm this result. In July, 1927, a batch of heavily-rusted oaten straw was collected at Cowra. It was cut into short lengths, partially dried out in the laboratory, and then divided into twenty-five equal packets for storage in the ice-house.

The first inoculation of a set of oat differentials was made on the 7th August. The reactions were those of *P. graminis avenae* 1, Joanette giving "2" reactions. This initial culture has since been kept alive. It was tested on the differentials again in January, 1928, and gave the expected reactions for *P. graminis avenae* 1, excepting that Joanette gave "4" reactions.

Packets were withdrawn from the ice-house at intervals of approximately a fortnight and tested in the usual way. Withdrawals on the 23rd August, 4th and 24th September, gave the normal reactions for Form 1. Withdrawals on the 2nd, 16th and 30th October varied inasmuch as Joanette gave an "X" reaction. Withdrawals on the 13th and 27th November gave a "4" reaction. Thereafter no uredospore germinations occurred, although withdrawals were tested.

Forms 1 and 2 are valid forms under low temperature, i.e., winter conditions for testing. Sets inoculated simultaneously with them and treated in the same fashion throughout have given flecks on Joanette in the one case and "4" reactions in the other.

Variation in Reaction of Puccinia triticina.

In studies dealing with the leaf rust of wheat, the Farrer wheat "Thew" was found to be resistant to one of the two forms that have been discovered. It was noticed that tests in the winter months showed the sharpest possible flecks, whilst in the summer the reaction was "4^c". A series of tests was carried out, using part of the grain of single plants in January, 1928, as a "summer test", and grain of the same plants in June, 1928, as a "winter test". In each case two cultures of each of the two forms were used. In addition to "Thew", there

were included cultures of "Webster", "Hope", and "Iumillo", received from Drs. E. C. Stakman and M. N. Levine, and also the series of differentials used by Dr. E. B. Mains in his determinative work and kindly supplied by him.

The results are shown in the following table:

TABLE 8.
Results of Summer and Winter Tests with two physiologic forms of *Puccinia triticina* on certain varieties of wheat.

Variety.	Australian Form 1.		Australian Form 2.	
	Summer.	Winter.	Summer.	Winter.
Thew..	4c	;	4	4
Webster E.C.S.	X	X	X	X
Hope..	4	X	4	X
Iumillo	4	X	4	X
Malakoff 4898–4	;	;	;	;
Hussar 4843–2	4	X	4	X
Norka 4377–2	;	;	;	;
Kawvale 5274–1	X	X	X	X
Democrat 3384–1	X	X	X	X
Webster 3780–8	X	X	X	X
Med. 3322–3	X	X	X	X
Unnamed 3747–5	X	X	X	X
Unnamed 3756–4	4	X	4	X
Unnamed 3778 Montana	4	4	4	4
Unnamed 3779–5	4	4	4	4

It will be seen that apart from "Thew", which serves to differentiate between the two Australian forms of leaf rust, any differences shown by Form 1 are also shown by Form 2. Some of the varieties are alike fully resistant under summer and winter conditions, whilst others are fully susceptible under both sets of conditions. In four of the cases, viz., Hope, Iumillo, Hussar, and Unnamed 3756, there is a noticeable difference. In the summer the reaction is fully susceptible, i.e., "4", whilst in the winter it is the indeterminate type "X".

Effect of Varying Plant-House Conditions upon Resistance to Puccinia simplex.

Working with a culture of the organism obtained from Werribee, tests were carried out to determine whether a change from a resistant to a susceptible reaction could be detected.

The first indication that this might be the case came from an attempt made in midsummer to illustrate heterozygosity in certain F_3 families of crosses between "Manchuria" and other susceptible varieties like "Cape" and "Skinless", which had previously given a normal ratio of 3 resistant to every 1 susceptible plant. These results had been obtained during the autumn and winter months. The summer results from ten different families were quite different; the sharp segregation into the expected groups of plants giving resistant flecks and sus-

ceptible "4" reactions did not occur. A repetition of the work gave the same result. It was therefore decided to make a comparative test under summer and winter conditions.

In studies on the inheritance of resistance to this rust (Waterhouse, 1923) it had been determined that certain varieties were fully susceptible in the plant house, giving a "4" type of reaction, others were moderately resistant, giving a "2" reaction, whilst some were resistant, giving flecks. Of the susceptible varieties, the following were taken: six of *Hordeum vulgare*, two of *H. intermedium*, four of *H. distichon*, and two of *H. deficiens*. All available varieties showing moderate resistance and a random group showing complete resistance were used. A single plant of each was used for the test, part of the grain being sown in summer (February, 1928) and part in the winter (July, 1928). The rust culture used was the one which had been used in the previous investigation.

The results are shown in the following table:

TABLE 9.

Comparison of reactions to a strain of *Puccinia simplex* shown by various barleys tested under summer and winter conditions.

Barley used.	Time and Result of Test.	
	Summer.	Winter.
Susceptible Class.		
Hordeum vulgare nigrum typica	4	4
H. vulgare atrum typica	4	4
Manchuria Sel. C81	4	4
Manchuria Sel. C225	4	4
Cape	4	4
Skinless	4	4
H. intermedium haxtoni typica	4	4
H. intermedium mortoni typica	4	4
H. distichon angustispicatum typica	4	4
H. distichon nudum typica	4	4
Kinver	4	4
Pryor	4	4
H. deficiens deficiens typica	4	4
H. deficiens steudelli typica	4	4
Moderately Resistant Class.		
Californian Feed	4	2 and X−
Psaknon	4	2+
Locride	4	2 and X−
Sahara 3770	4	2+
Orge Fourragère	4	2 and X
Minn. I 16.13 Lion	4	4[c]
Minn. II 20.10B	4	4[c]
Minn. II 21.14	4	2+

TABLE 9—*Continued.*

Barley used.	Time and Result of Test.	
	Summer.	Winter.
Resistant Class.		
H. vulgare aethiops typica	4	;
H. vulgare horsfordianum typica	4	;
Minn. II 21.15	4	;
Minn. II 21.17	4	;
Minn. II 21.18	4	;
Manchuria Sel. C163	4	;
Manchuria Sel. C168	4	;
Manchuria	4	;

It will be seen that there is no difference as between the summer and the winter reactions given by the susceptible varieties. The fluctuations that occurred in the environment did not appreciably affect the susceptibility.

In the case of the moderately resistant types, an appreciable change was apparent. Varieties which showed moderate resistance under winter conditions were completely susceptible under summer conditions. A change from a "2" or an "X" to a "4" is significant.

The resistant types gave a very important result. Under winter conditions they gave flecks, but under summer conditions they gave the completely susceptible "4" reaction. This was a very unexpected change. It explains why there was a failure to secure the expected segregation during the summer test in the crosses of "Manchuria" with "Cape", "Skinless" and "Kinver". The supposedly resistant "Manchuria" is not resistant under the summer conditions.

These results were obtained from only one year's test. A repetition of it is being made.

Summary.

It has been shown that important differences occur in the reactions of hosts to rust attack in the plant house. These differences may be extreme. Complete susceptibility shown by a rust under summer conditions may change to complete resistance in the winter. Since the determination of physiologic forms of rust is based upon the susceptibility or resistance shown on seedlings in the plant house, control of the environmental conditions becomes imperative. An intensive study of this change may give valuable information regarding the complex problem of the nature of rust resistance. No definite field observations have been made which indicate that in mature plants susceptibility may be shown under certain climatic conditions and resistance under others, but this happening may have an important bearing upon field practice, and epidemiology.

Specialization in Puccinia graminis tritici.

Identity of Physiologic Forms of P. graminis tritici *in Australia.*

The preceding results have shown that major differences in the rust reactions may be brought about by altering the environmental conditions under

which the tests are made. Complete susceptibility under summer conditions may change to complete resistance under winter conditions. This has not been occasioned on all the differentials. Nor do all physiologic forms react to such changes in the same degree.

This does not make invalid the determination of physiologic forms. But it makes it imperative that uniform conditions should prevail throughout the tests. Under identical environmental conditions different cultures of rusts behave quite differently on the differential hosts and can be sorted into distinct physiologic forms. The reactions given under normal plant-house conditions, i.e. not extremes of winter or of summer, have been used in the designation of the forms. The ranges do not include those given under these extremes.

Studies involving these determinations have been in progress at the University of Sydney since 1921. The kindness of Drs. Stakman and Levine in making available grain of their differential hosts has made it possible to carry out this work. The arrival of Form 33 in the uredospore stage from Dr. M. N. Levine, and the occurrence of Form 16 from Indian material and Form 27 from English teleutospore material have helped in checking the grain of the differentials. Many officers of the Department of Agriculture and others interested in plant-disease work have forwarded rusted material which has been used in the investigations.

In the following table are given the forms which have been met in the work. It should be clearly borne in mind that only seven of these have occurred naturally in Australasia, viz., 34, 43, 44, 45, 46, 54 and 55. Of these all but 34 have so far been recorded only in Australasia. The six purely Australasian forms exhibit a number of features of interest.

TABLE 10.

Behaviour of physiologic forms of *P. graminis tritici* as shown by the type of infection produced on the differential hosts.

Physiologic Forms.	Mean reactions on differentials.											
	Little Club C.I. 4066.	Marquis C.I. 3641.	Kanred C.I. 5146.	Kota C.I. 5878.	Arnautka C.I. 4072.	Mindum C.I. 5296.	Arnautka (Spelmars) C.I. 6236.	Kubanka C.I. 2094.	Acme C.I. 5284.	Einkorn C.I. 2433.	Vernal Emmer C.I. 3686.	Khapli C.I. 4013.
11	4	4	3++	3+	4	4	4	3++	3++	3	1=	1=
16	4=	2=	0	1	4	4	4	3+	3++	1=	1=	1=
27	4−	2	0	0	0;	0;	0;	4	3++	1=	3++	1+
33	4	2	3++	2	0;	0;	0;	4	3++	3	0;	1
34	4	4	3++	3++	4	4	4	3++	3++	1=	0;	1=
43	4	3++	0	0;	0;	0;	0;	X	1	3	1	0;
44	4	3++	0	0;	0;	0;	0;	3+	3+	3	1	0;
45	4	2	0	2−	4	4	4	X	X	3	3	1
45A	4	2	2	2−	4	4	4	X	X	3	3	1
46	4	3++	0	2−	4	4	4	1	1	3	3	1
54	4	3++	0	0;	0;	0;	0;	1	3+	3	1	0;
55	4	4	0	2−	4	4	4	X	X	3	3	1
New Form	4	3++	3++	3	0;	0;	0;	3	3	0;	0;	0;

The six Australasian forms fall into two groups. The three members of each group show marked interrelations. Forms 43, 44, and 54 vary only in their reactions on Kubanka and Acme. But that differences between them do occur is further shown by the studies of the reactions of other wheats to these forms. Similarly Forms 45, 46, and 55 show resemblances to each other, but are separable on Marquis, Kubanka and Acme. The first group of three has always given sharp resistance on Arnautka, Mindum and Spelmars, whilst in the second group these wheats are completely susceptible. It has been repeatedly noticed in warm weather inoculations of stock cultures on Federation, which is susceptible to all forms. that uredosori of the second group break through the epidermis and give crops of uredospores in a shorter time than do members of the first group. This, of course, refers to pots treated in the same fashion. Furthermore, members of the second group give large "4" pustules on Federation which, as they age, are often quite necrotic round the edges. This does not occur with members of the first group.

Colour Differences between Physiologic Forms.

Differences in the colour of the uredo pustules of the different forms seemed to occur. To test the point, cultures of each form on Federation seedlings were kept under the same conditions in the plant house at a season when these approached the optimum. The colours of the pustules were directly compared with the Ridgway Colour Standards. The following was the result:

Form 11	Sanford's Brown	Plate ii
Form 16	Burnt Sienna	Plate ii
Form 27	Burnt Sienna	Plate ii
Form 33	Antique Brown	Plate iii
Form 34	Sanford's Brown	Plate ii
Form 43	Burnt Sienna	Plate ii
Form 44	Sanford's Brown	Plate ii
Form 45	Sanford's Brown	Plate ii
Form 46	Antique Brown	Plate iii
Form 54	Sanford's Brown	Plate ii
Form 55	Antique Brown	Plate iii
New Form	Raw Sienna	Plate iii

That is to say the "new form" is unlike any of the others. Forms 11, 34, 44, 45 and 54 are alike. Forms 16, 27, and 43 are alike, and Forms 33, 46, and 55 are alike. It will be seen that this grouping does not accord with that made on the basis of the specialization and uredospore size of the forms.

An interesting case in connection with colour of the uredo pustules came under notice. In the determination of specialization of a culture of rust from Hawkesbury Agricultural College, the normal reactions of Form 34 were found. But on Marquis, one pustule was of a different colour from the others. It was much paler. A culture was obtained from this pustule as well as one from the ordinary darker pustules on the same host. Determinations on the differential sets showed that each was Form 34, but throughout the hosts the lighter colour was apparent in the one culture. When compared with the Ridgway Colour Standards it was found to be "Mars Yellow" of Plate iii, whilst the original culture was "Sanford's Brown" of Plate ii. When the wheat straw from which the culture was first started was examined, no trace could be found of a colour

difference in the rust present. It is considered that this light-coloured strain of Form 34 arose as a mutation. It has since been kept in culture and frequently tested on the differentials without showing any departure from the original colour and reactions, excepting that, like Form 34, it responds strikingly to differences in the summer and winter conditions as shown by the reactions on the durums. A case of colour mutation in *P. graminis tritici* is recorded by Newton and Johnson (1927). The occurrence of mutations in stem rust may have an important bearing on the origin of physiologic forms of the organism.

Distribution of the Forms.

Since the commencement of the studies in May, 1921, efforts have been made to secure samples of rusted material as frequently as possible and from as many sources as possible. The ideal method, of paying frequent personal visits to different localities in order to collect specimens, has not often been practicable, although a number of centres have been visited from time to time. The survey, therefore, has been mainly dependent upon the kindness of helpers in submitting rusted samples for study. Officers of the New South Wales Department of Agriculture have contributed very largely to this work.

The results are summarized hereunder, grouped into periods, each of one year. Empirically, the end of March has been taken as closing each period of twelve months. Early sowing of crops takes place in April, and this month has been selected as the commencement of each of the periods set out.

First Period: May, 1921 – March, 1922.

The first stem rust received and subjected to test came from Hawkesbury Agricultural College and proved to be Form 43. From Cowra in September the same form came to hand, and this particular culture has been kept growing ever since as the standard Form 43. During the period, forty-one different isolations were made from material which was received from thirty-four different Australasian localities. Five of the physiologic forms were represented in the collections.

The details of these are set out in the following table:

TABLE 11.
Results of investigations of uredospore material received from various sources in 1921–1922.

Form No.	Total Number of Isolations.	Number of different localities from which material came.					
		New South Wales.	Victoria.	Queensland.	South Australia.	Tasmania.	New Zealand.
43	20	15		1			
44	2	2					
45	3	1			1		
46	14	5	1	1	1	3	1
55	2	2					
Totals	41	25	1	2	2	3	1

The only State not represented is Western Australia. Considering a grouping of the forms as already suggested, it will be seen that Group 1 was represented in twenty-two of the isolations, and Group 2 in nineteen. The distribution of the latter is much the wider.

In addition to these isolations, it may be mentioned that Form 27 was isolated as the result of inoculating a barberry with sporidia from teleutospore material kindly forwarded from Milton, Wales, by A. D. Cotton, Esq., of Kew.

The different places of collection were as follows:

Form 27: Wales.

Form 43: Hawkesbury Agricultural College, Cowra, Packham, Coonamble, Trangie, Nyngan, Nowra, Yanco, Grafton, Temora, Wagga, Bankstown, University of Sydney Plots, Glen Innes, Bathurst, Gatton (Q.).

Form 44: Camperdown, Nemingha.

Form 45: Bathurst, Roseworthy (S.A.).

Form 46: Coonamble, Glen Innes, Wagga, Wellington, Newstead, Gatton (Q.), Roseworthy (S.A.), Werribee (Vic.), Devonport (Tas.), Central Tasmania, Southern Tasmania, Longford (N.Z.).

Form 55: Loomberah, Glen Innes.

Second Period: April, 1922 – March, 1923.

Only fifteen isolations in all were made, very little material coming to hand from the various States. Three forms were represented, as shown in the following table:

TABLE 12.
Results of investigations of uredospore material received from various sources in 1922–1923.

Form No.	Total Number of Isolations.	Number of different localities from which material came.			
		New South Wales.	Queensland.	South Australia.	Western Australia.
43	10	5	1		1
44	4	2			
54	1			1	
Totals	15	7	1	1	1

In addition, Form 33 was received from Dr. M. N. Levine, of Minnesota, during this period.

The different places of collection were as follows:

Form 33: Minnesota (U.S.A.).

Form 43: Hawkesbury Agricultural College, Bathurst, Glen Innes, University of Sydney Plots, Wagga, Pittsworth (Q.), Chapman (W.A.).

Form 44: Glen Innes, Inverell.

Form 54: Roseworthy (S.A.).

Third Period: April, 1923 – March, 1924.

In this period, twenty-five isolations were made from Australasian material representing four States, as set out in the following table:

TABLE 13.
Results of investigations of uredospore material received from various sources in 1923–1924.

Form No.	Total Number of Isolations.	Number of different localities from which material came.			
		New South Wales.	Victoria.	Western Australia.	Tasmania.
43	10	6		1	
46	15	2	2		1
Totals	25	8	2	1	1

In addition there were two isolations of Form 27 from teleutospore material collected at Milton, Wales, by Miss K. Sampson, of the University of Wales.

The different places of collection were as follows:

Form 27: Wales.

Form 43: Hawkesbury Agricultural College, Cowra, University of Sydney Plots, Wagga, Leeton, Bathurst, Chapman (W.A.).

Form 46: Cowra, Bathurst, Rutherglen (Vic.), Werribee (Vic.), Devonport (Tas.).

Fourth Period: April, 1924 – March, 1925.

More material came to hand during this period. It comprised 100 isolations in which were represented five forms, as shown in the following table:

TABLE 14.
Results of investigations of uredospore material received from different sources in 1924–1925.

Form No.	Total Number of Isolations.	Number of different localities from which material came.				
		New South Wales.	Victoria.	Queensland.	South Australia.	Tasmania.
43	55	24	3	1	1	
44	1		1			
45	15	4	1		1	
46	24	10		1		4
55	5	3				
Totals	100	41	5	2	2	4

Here again it will be noticed that if the forms be grouped, Group 1 is represented in fifty-six of the isolations and Group 2 in forty-four.

The different places of collection are as follows:

Form 43: Hawkesbury Agricultural College, Cowra, Manilla, Delungra, Kelvin, Grafton, Trangie, Tamworth, Duri, Inverell, Coonamble, Parkes, Colinroobie, Bathurst, Illabo, Wagga, University of Sydney Plots, Roseville, Narromine, West Wyalong, Urana, Koorawatha, Mandialla, Young, Gatton (Q.), Dookie (Vic.), Werribee (Vic.), Euchareena (Vic.), Roseworthy (S.A.).

Form 44: Werribee (Vic.).

Form 45: Hawkesbury Agricultural College, Illabo, Wagga, Cowra, Werribee (Vic.), Roseworthy (S.A.).

Form 46: Hawkesbury Agricultural College, Kelvin, Manilla, Tamworth, Duri, Parkes, Henty, Wagga, Peak Hill, Eugowra, Gatton (Q.), Westbury (Tas.), Wesley Vale (Tas.), North Downs (Tas.), Devonport (Tas.).

Form 55: Roseville, Eumungerie, Cowra.

Fifth Period: April, 1925 – March, 1926.

Only twenty-eight collections were available, covering five forms as set out hereunder.

TABLE 15.
Results of investigation of uredospore material received from various sources in 1925–1926.

Form No.	Total Number of Isolations.	Number of different localities from which material came.		
		New South Wales.	Queensland.	Western Australia.
34	4			2
43	15	4	1	
44	3	2	1	
45	5	3		
46	1	1		
Totals	28	10	2	2

It is important to note the advent of Form 34. The material from Western Australia was forwarded by Mr. W. M. Carne and consisted of a large representative sample of rusted straw from the wheat and barley crops. The actual culture obtained has since been grown in the plant house and is the one used as the type culture of Form 34.

The different places of collection were as follows:

Form 34: Ejading (W.A.), Northam (W.A.).

Form 43: Hawkesbury Agricultural College, University of Sydney Plots, Roseville, Grafton, Gatton (Q.).

Form 44: Glen Innes, Bathurst, Gatton (Q.).

Form 45: Hawkesbury Agricultural College, University of Sydney Plots, Grafton.

Form 46: Grafton.

Sixth Period: April, 1926 – March, 1927.

In this year, eighty-nine isolations were made. They included all the known seven Australasian forms as shown hereunder.

TABLE 16.

Results of investigations of uredospore material from various sources in 1926–1927.

Form No.	Total Number of Isolations.	Number of different localities from which material came.				
		New South Wales.	Queensland.	South Australia.	Western Australia.	New Zealand.
34	18	6		2	3	
43	14	8	1	1		
44	30	14	1	2		
45	17	9		1		1
46	6	5				1
54	3	3				
55	1	1				
Totals	89	46	2	6	3	2

On the system of grouping the six forms other than Form 34 into the two groups each of three forms, it will be seen that there are forty-seven isolations of the first group and twenty-four of the second.

The different places of collection were as follows:

Form 34: Curlewis, Manilla, Cowra, Wagga, Loomberah, Bathurst, Bordertown (S.A.), Waite (S.A.), Lake Grace (W.A.), Salmon Gums (W.A.), Chapman (W.A.).

Form 43: Hawkesbury Agricultural College, Oberon, Bathurst, Wagga, Narromine, Grafton, Goonoo Goonoo, Curlewis, Gatton (Q.), Mt. Gambier (S.A.).

Form 44: Hawkesbury Agricultural College, Grafton, Curlewis, Tamworth, Armidale, Yanco, Narrandera, Beddon, Curban, Cowra, Currabubula, Coonamble, Bathurst, Roseville, Gatton (Q.), Lucindale (S.A.), Millicent (S.A.).

Form 45: Curlewis, Yanco, Narrandera, Griffith, Beddon, Curban, Tooraweenah, Cowra, Bathurst, Waite (S.A.), Ashburton (N.Z.).

Form 46: Tullamore, Balladoran, Gilgandra, Canowindra, Chandler, Nelson (N.Z.).

Form 54: Dubbo, Balladoran, Tooraweenah.

Form 55: Cowra.

Seventh Period: April, 1927 – March, 1928.

In this period there were 189 isolations. All the States and New Zealand are represented. As in the preceding year, all seven forms were represented in the collections, which are set out in detail hereunder.

TABLE 17.
Results of investigations of uredospore material from various sources in 1927–1928.

Form No.	Total Number of Isolations.	Number of different localities from which material came.						
		New South Wales	Victoria.	Queensland.	South Australia.	Western Australia.	Tasmania.	New Zealand.
34	152	31	1	2	1	4	6	1
43	21	6					1	
44	6	2		1			1	
45	5	3					1	
46	2	2						
54	1	1						
55	2	1		1				
Totals	189	46	1	4	1	4	9	1

In this period Form 16 was also isolated from teleutospore material kindly forwarded from Pusa, India, and used to infect a barberry.

The actual places of collection were as follows:

Form 16: Pusa, India.

Form 34: Hawkesbury Agricultural College, Glen Innes, Bathurst, Raleigh, Gowrie, Trangie, Grafton, Trundle, Botfield, Daroobalgie, Bogan Gate, Cowra, Quandong, Parkville, Warrah Creek, Quipolly, Quirindi, Duri, Dubbo, Young, Quaker's Hill, Ben Lomond, Sunnyside, Guyra, Armidale, Leeton, Carcoar, Currabubula, Werris Creek, University of Sydney Plots, Roseville, Gatton (Q.), Darling Downs (Q.), Werribee (Vic.), Monarto (S.A.), Kwolyin (W.A.), Chapman (W.A.), Dindiloa (W.A.), Merredin (W.A.), Sassafras (Tas.), W. Devonport (Tas.), North Down (Tas.), Barrington (Tas.), Scottsdale (Tas.), Stonor (Tas.), Nelson (N.Z.).

Form 43: Hawkesbury Agricultural College, Bathurst, Glen Innes, Raleigh, Peak Hill, Grafton, Barrington (Tas.).

Form 44: Glen Innes, Bathurst, Gatton (Q.), North Down (Tas.).

Form 45: Glen Innes, Cowra, Warrah Creek, Barrington (Tas.).

Form 46: Quandong, Carcoar.

Form 54: Gowrie.

Form 55: Trangie, Darling Downs (Q.).

Eighth Period: April, 1928 – March, 1929.

There were 156 isolations in the year. They came from numerous localities. Only Form 34 was present. The details are as in Table 18.

Material came to hand late in the season from Western Australia, but the uredospores had unfortunately lost viability. It is believed, however, that it was Form 34.

During this period two other forms were added to the collection, viz., Form 11 and the "New Form" (Waterhouse, 1929).

TABLE 18.
Results of investigations of uredospore material from various sources in 1928–1929.

Form No.	Total Number of Isolations.	Number of different localities from which material came.				
		New South Wales.	Victoria.	Queensland.	South Australia.	New Zealand.
34	156	36	7	4	3	1

The different places of collection were as follows:

Form 34: Hawkesbury Agricultural College, Bathurst, Lewis Ponds, Cowra, Boggabri, Trangie, Yanco, Pinecliff, Chatswood, Henty, Duri, Coonamble, Wyalong, Wagga, Brocklesby, Loomberah, University of Sydney Plots, Jindera, Berrigan, Grafton, Toogong, Gunnedah, Currabubula, Tamworth, Dubbo, Wellington, Narromine, Barellan, Lockhart, Forbes, Oaklands, Corowa, Peak Hill, Gowrie, Glen Innes, Inverell, Gatton (Q.), Freestone (Q.), Loch Lomond (Q.), Gladfield (Q.), Werribee (Vic.), Dookie (Vic), Howlong (Vic.), Rutherglen (Vic.), Port Prairie (Vic.), Shepparton (Vic.), Willaura (Vic.), Waite (S.A.), Glencoe West (S.A.), Furner (S.A.), Nelson (N.Z.).

The whole of these results are summarized in the following tables:

TABLE 19.
Summary of the uredospore investigations showing the number of isolations and different localities from which they came during the several periods.

Form No.	Season ending March of																Total Number of Isolations.
	1922.		1923.		1924.		1925.		1926.		1927.		1928.		1929.		
	Isolations.	Localities.	Isolations.	Localities.	Isolations.	Localities.	Isolations.	Localities.	Isolations.	Localities.	Isolations.	Localities.	Isolations.	Localities.	Isolations.	Localities.	
34									4	2	18	11	152	46	156	51	330
43	20	16	10	7	10	7	55	29	15	5	14	10	21	7			145
44	2	2	4	2			1	1	3	3	30	17	6	4			46
45	3	2					15	6	5	3	17	11	5	4			45
46	14	12			15	5	24	15	1	1	6	6	2	2			62
54			1	1							3	3	1	1			5
55	2	2					5	3			1	1	2	2			10
Totals	41	34	15	10	25	12	100	54	28	14	89	59	189	66	156	51	643

If the grouping of the six forms into the two groups each of three forms be considered, it is seen that of Group 1, comprising Forms 43, 44 and 54, there were in all 196 isolations. Of Group 2 comprising Forms 45, 46 and 55, there were 117 isolations. The remaining 330 isolations were of Form 34.

TABLE 20.
Summary of the uredospore investigations showing the different localities each season from which the forms came.

Form No.	Total Number of Isolations.	Different localities from which material came.							
		New South Wales.	Victoria.	Queensland.	South Australia.	Western Australia.	Tasmania.	New Zealand.	Total Number of Localities.
34	330	73	8	6	6	9	6	2	110
43	145	73	3	5	2	2	1		86
44	46	22	1	3	2		1		29
45	45	20	1		3		1	1	26
46	62	25	1	2	1		8	2	39
54	5	4			1				5
55	10	7		1					8
Totals	643	154	14	17	15	11	17	5	303

Here again it is instructive to group the forms into the two groups, each of three forms. The first group came from 120 different localities, the second group from 73 different localities, and Form 34 from 110 different localities.

In considering these results, attention is again directed to the limitations imposed upon the collecting of specimens, and to the fact that, in the main, dependence had to be placed upon agents not directly concerned in these studies. The number of isolations for the various seasons cannot therefore be taken as a true index to the amount of rust present in the crops. In 1928 and 1929 rust was very prevalent in many areas, a fact brought out by the numerous isolations that were made. But in certain of the other periods when only few specimens came to hand, it is known that rust was present in the crops to a considerable extent.

Form 43.—It has already been stated that the first form which was determined was Form 43. With the exception of Form 34, this form turned up more frequently than any other during the eight years. It also came from more localities than any other form excepting 34. Furthermore it was determined during each of the periods, with the exception of 1928–1929, when only Form 34 occurred. All the Australian States have provided isolations of this form, but it has not been recorded from New Zealand.

Form 44.—This form, which is allied to Form 43, also appeared in the early stages of the work, and occurred fairly frequently during the investigations, excepting during the 1923-1924 period, when so few isolations were made. It came from four of the Australian States.

Form 45.—This is a member of the second group, and appeared fairly frequently. It was isolated during the first period, and only dropped out during the 1923 and 1924 periods when only a few collections were available. Queensland and Western Australia have not yielded isolations of it, but the other States and New Zealand have.

Form 46.—This was the second form to be isolated in Australia, occurring early in the investigations and showing very marked differences from the first form that was found, viz., Form 43. It is a member of the second group of forms.

In frequency of isolation, as well as in the number of localities from which it came, it ranks next to Form 43. It was found in each period up to 1928, with the exception of 1923, when so very little material came to hand. With the exception of Western Australia, all the Australian States and New Zealand have harboured this form.

Form 54.—This is a member of the first group of forms and has been isolated only five times during the periods 1923, 1927, and 1928. New South Wales and South Australia are the only States in which it has been found.

Form 55.—This member of the second group has only been isolated ten times, and has come from New South Wales and Queensland.

Regarding these six forms on the basis of their grouping, it will be seen that members of Group 1 were isolated 196 times and members of Group 2 117 times. Members of Group 1 came from 119 localities, whilst those belonging to Group 2 came from 73 localities.

Form 34.—This form differs markedly from the other six forms. They are essentially Australian, not having been recorded from other countries. Form 34 has been recorded from several other continents. It is a very much more virulent form than the other six.

It will be seen that during the first four periods of the investigations, Form 34 did not once show up. It was first found in November, 1925, after the investigation had been in progress for four and a half years. During that time, 193 determinations of other forms had been made. The material containing it was heavily-rusted wheat and barley straw sent by Mr. W. M. Carne from Western Australia. It was not found again until just a year later, when Mr. Carne again forwarded a batch of Western Australian material. At about the same time (November, 1926) Form 34 was isolated from rusted wheat sent from several localities in New South Wales and South Australia. At the same time forms belonging to one or other of the two groups were coming to hand. In some cases the one collection of straw yielded Form 34 together with one of the other forms. Gradually the latter became fewer. The 1928 period shows that from 189 isolations, Form 34 occurred 152 times. The localities from which it came also showed a remarkable extension. Every Australian State, as well as New Zealand, gave isolations of this form. Even more striking is the position revealed in the 1929 period. From 156 isolations, only Form 34 was obtained. There was no appearance of any one of the other forms during this period. Form 34 completely dominated the situation. Tasmania failed to submit rusted material, but all the other States, as well as New Zealand, sent rusted straw carrying Form 34 and only this form. The last isolation of a form other than 34 occurred in January, 1928, from rusted material obtained from Tasmania.

In the collections examined there were numerous cases in which more than one form of rust were present. Leaf rust and stem rust frequently appeared together; the most convenient host for separating them was Khapli. As many as three distinct physiologic forms of stem rust were found in the one collection. It has been a very common occurrence to find both the forms of leaf rust present in a batch of material and sometimes on the same leaf of a plant.

The advent of such a form as 34 profoundly affects the rust situation. It has been found that few varieties of wheat of commercial value are resistant to it, and its attack on cross-bred wheats known to be resistant to the other forms which had been isolated was very upsetting.

Occurrence of P. graminis tritici *on other Hosts.*

In addition to attacking wheat, *P. graminis tritici* is known to occur on other plants. Whenever possible, these other hosts have been examined, with a result indicated in the following section.

Barley.

This is a crop which is not very extensively grown in Australia. To date fifty-seven cultures of barley stem-rust have been examined. They came from all the States. Of the seven physiologic forms known to occur in Australia, five occurred in these barley isolations. Forms 54 and 55, which were not represented, have only been found, in all, on five and ten occasions respectively. Seedling tests have shown that the commercial varieties of barley are susceptible to these two forms. Had more extensive collections been available it is likely that natural infections with them would have been discovered.

The results of the collections are summarized hereunder:

TABLE 21.

Number of times isolations of the different physiologic forms were made from barley.

Form No.	Number of isolations.
34	28
43	13
44	7
45	3
46	6
Total	57

The numbers dealt with are small, but a comparison of these figures with the total number of isolations made of each of the forms shows a general agreement.

Rye.

Whenever it has been possible, rye crops have received special attention. Stem rust was first found on rye at Glen Innes in 1922. Fresh uredospores were inoculated on to seedlings of the same variety ("Black Winter") without giving any result. The next collection was from Hawkesbury Agricultural College in 1924, when a similar failure was encountered. Two years later a further sample came to hand from Grafton. Seedlings of wheat, oats, barley and rye were inoculated. Infections were obtained on the wheat and barley alone. Tests on the standard differentials showed that the rust was *P. graminis tritici* 44. Shortly afterwards another collection of rust on rye from Queensland proved to be *P. graminis tritici* 43. Thereafter stem rust on rye has occasionally been collected from various sources in New South Wales, Victoria and Queensland. Fourteen samples of viable material have been available and have yielded one isolation of Form 43, two of Form 44, and eleven of Form 34. The last mentioned have all turned up since November, 1927.

On several occasions there have been opportunities for scrutinizing crops of rye nearing maturity. Stem rust is uncommon in the crop. In coastal areas there have been numerous cases of leaf rust occurring on the sheath and on the stem itself. As showing the paucity of stem rust, in 1927 a careful search through a field of Slav rye at Cowra, in a season when rust was plentiful in wheat and oats, yielded only one plant infected with stem rust. The grain was at the dough stage. It was collected and the grain allowed to mature whilst a culture of the rust (Form 34) was kept growing. Tests with seedlings derived from this infected plant gave two susceptible and thirty-nine resistant plants. The two susceptibles and representatives of each of the resistant types were grown to maturity and selfed. No viable grain was obtained, so the experiment lapsed.

This work is being carried further forward and promises to yield interesting results. Efforts have been made to find rye plants infected with stem rust and to secure grain from them. In this work valuable help has been rendered by Mr. G. S. Gordon of Werribee, Mr. J. T. Pridham and Dr. A. R. Callaghan of Cowra, and Mr. W. H. Darragh of Grafton. In a few cases, rusted rye plants were found sufficiently early in the season to make it possible to bag some heads prior to flowering and thus secure a little selfed grain in addition to the open-pollinated grain. There were three of these plants. The yield of grain from these bagged heads was very light, numbering only 12, 2, and 9 grains respectively.

The grain of the individual plants was tested with Form 34, which was the attacking form, and after note-taking, the seedlings were planted out into open beds where they are being grown to maturity. The object is to obtain selfed grain of plants belonging to each class of rust reaction, and to test the progeny for resistance.

The results of these G1 tests are shown in Table 22.

TABLE 22.
Means of reactions given by rye seedlings inoculated with Form 34.

Acc. No.	Source.	Variety.	Mode of Pollination.	0	;	1	2	X	3	4
624	Cowra	Slav	Open	17	22	2		2		
955A	,,	Black Winter	,,	38	50	2	5	1	26	
955A	,,	,,	Selfed	3	1		1		7	
984	Bathurst	,,	Open	9	10	4	10	2	6	
987A	Grafton	,,	,,		3		1		2	
987B	,,	,,	,,	1	1	1		1		
987C	,,	,,	,,	5	5	2	8			
987D	,,	,,	,,	8	3					
1015M1	Werribee	March	,,	26	30		4	2	7	
1015B1	,,	Black Winter	,,	20	42	19	23	14	40	
1015B2	,,	,,	,,	27	29	8	13	6	11	
1015B3	,,	,,	,,	5	38	8	10	4	12	
1015B5	,,	,,	,,	22	6	4	4	1	15	
1015P1	,,	Petkus Rug	,,	43	9		5		12	
	,,	,,	Selfed				1		1	
1015P2	,,	,,	Open	14	20	13			18	
	,,	,,	Selfed						9	
Total of open-pollinated plants				235	268	63	83	33	149	

It will be seen that the seedlings derived from selfed grain of susceptible plants were mostly susceptible. One of the plants produced nine seedlings which were all susceptible. In the aggregate, of the twenty-three selfed grains derived from these three susceptible plants, seventeen were susceptible and six were resistant. Until further results are available it will not be possible to give an adequate explanation of the happenings. Is it a coincidence that when the sum total of the reactions given by the open-pollinated plants is taken, there are 649 resistant to 182 susceptible plants, a near approach to a 3 : 1 ratio? The results obtained from the tests on the next generation plants should give an answer.

Grasses as Hosts of P. graminis tritici.

It has long been recognized that grasses may play a part as hosts of the cereal rusts. Numerous investigators have given attention to the problem. Stakman and Piemeisel (1917) summarize the results of previous work and report the results of their extensive studies. They conclude that grasses are unquestionably important in the cereal rust problem.

In Australia McAlpine (1906) has recorded the occurrence of *Puccinia graminis* on a number of grasses, but was unable to carry out infection experiments with them. It is therefore uncertain whether wheat stem-rust was present, or whether it was some other variety of *P. graminis*.

Collections of rusts on grasses have been examined wherever possible during the present investigations. So far twenty-four cultures of wheat stem-rust have been studied, occurring on five different grasses. The determinations of the physiologic forms concerned have shown that five out of the seven physiologic forms known in Australia have occurred naturally on the grasses. Forms 54 and 55, which were not represented, have been obtained, in all, only five and ten times respectively in the course of the studies. It is therefore hardly surprising that they were not found on grasses.

After the determinations on the standard differentials of the physiologic forms concerned, it has been the practice to inoculate the initial grass-host of the particular rust with the culture taken from the wheat differential hosts. By this means the susceptibility of the grass to the particular form has been checked.

The results are summarized in Table 23.

It will be seen that Barley Grass, *Hordeum murinum*, was found eleven times infected with *P. graminis tritici*. Four out of the five physiologic forms which occurred on grasses were found on it. Taking into account the fact that *P. graminis avenae* also commonly occurs on barley grass, its importance as a rust host becomes evident. Its widespread occurrence throughout the wheat-belt further emphasizes this. Although it dries off in the early summer, it may function in the early part of the season in infecting the growing crops of wheat and oats.

Hordeum maritimum infected with rust was found only once. It was carrying both wheat and oat stem-rusts as shown in the tables.

Agropyron scabrum bearing rust was collected on eight occasions. All five forms occurring on grasses were isolated from it. Like Barley Grass, it is also naturally attacked by *P. graminis avenae*.

Arrhenatherum avenaceum in a rusted state was examined three times. A different physiologic form was present in each instance.

Echinopogon ovatus infected with rust was found once. The rust present was Form 43. It also serves as a host for *P. graminis avenae.*

TABLE 23.

Number of times certain grasses were found infected with physiologic forms of *Puccinia graminis tritici.*

Form 34.		Form 43.		Form 44.		Form 46.		Form 45.	
No. of collections.	Grass.	No. of collections.	Grass.	No. of collections.	Grass.	No. of collections.	Grass.	No. of collections.	Grass.
6	*Hordeum murinum*	1	*Hordeum murinum*	1	*Hordeum murinum*	1	*Agropyron scabrum*	3	*Hordeum murinum*
1	*Hordeum maritimum*	3	*Agropyron scabrum*	1	*Agropyron scabrum*			1	*Agropyron scabrum*
2	*Agropyron scabrum*	1	*Echinopogon ovatus*	1	*Arrhenatherum avenaceum*				
1	*Arrhenatherum avenaceum*	1	*Arrhenatherum avenaceum*						
10		6		3		1		4	

Other Grass Rusts.

The stem rusts which have occurred on grasses other than cereals have already been listed. In addition to these, there have been many collections of other grass rusts which have been subjected to test. The practice has been to use the material for inoculating pots of wheat, oats, barley and rye. Where infections were obtained, specialization studies were made and then the rust on the cereal seedlings used to inoculate the grass host on which it first occurred.

Rusts from the following grasses have failed to give any cereal infections: *Alopecurus geniculatus, Andropogon pertusis, Aristida vagans, A. behriana, Bromus mollis, B. racemosus, Cynodon dactylon, Danthonia bipartita, D. semiannularis, Festuca Hookeriana, Heteropogon contortus, Imperator arundinacea, Lamarckia aurea, Microloena stipoides, Panicum sanguinale, Stipa flavescens, S. pubescens.*

Several other grass rusts which produce a certain degree of infection of some of the cereal seedlings are being studied. When the results are complete they will be separately reported. In this work there are numerous indications that successful infection of the cereals takes place in the plant house during the summer with its high temperature, whereas no effect is produced during the winter.

Plant-House Investigations with Grasses for Susceptibility to Rust.

In addition to the work dealing with the rusts which occurred naturally on grasses, studies have been made of grasses inoculated in the plant-house with known forms of various rusts. The practice has been to use stock cultures for

the inoculation and, where the result has been successful, then to inoculate the appropriate cereal seedlings with the rust on the grass and prove its identity. The stem rusts have received chief attention. Many of the tests have yielded negative results.

As far as the work has gone the results may be summarized as follows:

Grasses tested with *Puccinia graminis tritici.*

Susceptible.—Aegilops divaricata, A. ovata, A. triticoides, A. ventricosa, Agropyron scabrum, Bromus tectorum, B. hordeaceus, B. arenarius, B. racemosus, Hordeum murinum, H. maritimum.

Slightly attacked.—Aegilops comosa, Avena elatior, Bromus maximus, B. unioloides, Briza major, B. minor, Ehrharta longiflora, Festuca bromoides, Koehleria cristata.

Immune.—Agropyron tenereum, Agrostis exarata, Anthoxanthum odoratum, Alopecurus pratensis, Bromus mollis, B. erectus, B. inermis, Festuca ovina, Holcus lanatus, Hordeum jubatum, H. bulbosum, Lolium temulentum, L. perenne, L. Italicum, L. subulatum, Lamarckia aurea, Poa pratensis, P. annua, Phleum pratense.

In most of these tests all thirteen physiologic forms which are available have been used. Some of the results show that the grass is susceptible to all the forms. In other cases there are differential reactions.

Grasses tested with *Puccinia triticina.*

Susceptible.—Aegilops divaricata, A. ovata, A. triticoides, A. ventricosa, Hordeum murinum, H. maritimum.

Slightly attacked.—Aegilops comosa, Agropyron scabrum, Avena elatior, Bromus maximus, B. racemosus, Briza minor, Festuca bromoides.

Immune.—Agropyron tenereum, Agrostis exarata, Anthoxanthum odoratum, Alopecurus pratensis, Bromus unioloides, B. arenarius, Briza major, Ehrharta longiflora, Festuca ovina, Hordeum jubatum, Koehleria cristata, Lolium temulentum, L. perenne, L. Italicum, L. subulatum, Poa annua.

Both the known physiologic forms have been used in these tests. Only in the case of *Aegilops ovata* was a differential reaction shown. Aust. 1 showed resistant and Aust. 2 susceptible reactions on this grass.

Grasses tested with *Puccinia graminis avenae.*

Susceptible.—Bromus maximus, B. hordeaceus, B. tectorum, Briza minor, B. major, B. arenarius, B. racemosus, Festuca bromoides, Hordeum murinum, H. maritimum, Koehleria cristata, Bechmannia erucaeformis.

Slightly attacked.—Aegilops ovata, Avena elatior, Bromus maximus, B. unioloides, Ehrharta longiflora, Lolium temulentum, L. perenne, L. subulatum.

Immune.—Aegilops comosa, A. divaricata, A. triticoides, A. ventricosa, Agropyron scabrum, A. tenereum, Agrostis exarta, Aira caryophyllata, Anthoxanthum odoratum, Alopecurus pratensis, Bromus erectus, B. inermis, Festuca ovina, Lolium Italicum, Phleum pratense, Poa annua.

All the available physiologic forms have been used in these tests. In a few cases differential reactions have been shown by the forms.

Grasses tested with *Puccinia simplex.*

Susceptible.—Hordeum murinum.

Slightly attacked.—Aegilops ventricosa, Briza minor, Hordeum maritimum.

Immune.—Aegilops divaricata, A. ovata, Agropyron scabrum, Avena elatior, Bromus maximus, B. unioloides, B. arenarius, B. racemosus, Briza major, Ehrharta longiflora, Festuca bromoides, Holcus lanatus, Hordeum bulbosum, Koehleria cristata, Lolium temulentum, L. perenne, L. subulatum.

Grasses tested with *Puccinia coronata.*

Susceptible.—Aegilops ovata, Briza minor, Bromus racemosus, Hordeum maritimum.

Slightly attacked.—Aegilops divaricata, A. triticoides, A. ventricosa, Bromus unioloides, Festuca bromoides, Hordeum murinum, Lolium temulentum.

Immune.—Agropyron scabrum, Bromus maximus, B. arenarius, Briza major, Ehrharta longiflora, Holcus lanatus, Lolium temulentum, L. perenne, L. subulatum, Poa annua.

Grasses tested with *Puccinia dispersa.*

Slightly attacked.—Aegilops ovata.

Immune.—Aegilops divaricata, A. triticoides, A. ventricosa, Avena elatior, Bromus maximus, B. unioloides, B. racemosus, B. arenarius, Briza minor, B. major, Ehrharta longiflora, Festuca bromoides, Hordeum murinum, H. maritimum, Holcus lanatus, Lolium temulentum, L. perenne, L. subulatum, Poa annua.

Specialization in Puccinia graminis avenae.

Studies of the organism causing stem rust of oats have revealed in other countries the occurrence of five physiologic forms. In the present investigations some attention has been paid to this rust, thanks to the kindness of Drs. Stakman and Levine in forwarding grain of their differential hosts. In 1921, grain of Victory, Ligowo, White Tartar, Green Mountain and Richland were received. Joanette was sent in 1925. Therefore determinations prior to this date were imperfect. They showed that the Form present was either Form 1, 2 or 5, since in no case was White Tartar or Richland susceptible. These determinations are consequently not included in the results recorded.

Tables 24 and 25 summarize the results obtained.

It will be seen that 150 isolations were studied. They came from all the Australian States and New Zealand, although the great majority came from New South Wales.

The different localities from which material came are as follows, taking the season as ending in March of the year stated:

1925. Form 1: Hawkesbury Agricultural College, Cowra, Epping, Trangie, Dubbo, Inverell, Coonamble, Tamworth, Eugowra, Wagga, Glen Innes, Woniora River, Gatton (Q.), Werribee (Vic.), Dookie (Vic.), Adelaide (S.A.), Christchurch (N.Z.).

Form 2: Cowra.

1926. Form 1: Bathurst, Glen Innes, Gatton (Q.).

1927. Form 1: Hawkesbury Agricultural College, Currabubula.

Form 2: Willow Tree, Yanco, Grafton, Cowra, Coonamble, Bathurst, Oberon, Waite (S.A.), Allandale (S.A.), Merredin (W.A.), Ashburton (N.Z.).

TABLE 24.
Summary of investigations of uredospore material of *P. graminis avenae* derived from different sources in Australasia.

Form No.	Total Number of Isolations.	Period ending March of									
		1925.		1926.		1927.		1928.		1929.	
		Isolations.	Localities.	Isolations.	Localities.	Isolations.	Localities.	Isolations.	Localities.	Isolations.	Localities.
1	50	29	17	3	3	2	2	8	6	8	4
2	81	1	1			19	11	30	18	31	14
6	8							2	2	6	2
7	11							7	5	4	3
	150	30	18	3	3	21	13	47	31	49	23

TABLE 25.
Summary of investigations of uredospore material of *P. graminis avenae* showing distribution in Australasia.

Form No.	Total Number of Isolations.	Total Number of Localities.	Different localities from which material came.						
			New South Wales.	Victoria	Queensland.	South Australia.	Western Australia.	Tasmania.	New Zealand.
1	50	32	23	4	2	1	1		1
2	81	44	34	2		4	1	2	1
6	8	4	3	1					
7	11	8	3					5	
	150	88	63	7	2	5	2	7	2

1928. **Form 1**: Hawkesbury Agricultural College, Glen Innes, Cowra, Roseville, Werribee (Vic.), Chapman (W.A.).
Form 2: Hawkesbury Agricultural College, Glen Innes, Cabramatta, Bathurst, Wagga, Cowra, Coramba, Dubbo, Roseville, Ben Lomond, Armidale, Glenfield, Leeton, Yanco, University of Sydney Plots, Monarto (S.A.), Barrington (Tas.), Tunnack (Tas.).
Form 6: Hawkesbury Agricultural College, Grafton.
Form 7: Barrington (Tas.), Sheffield (Tas.), Parattah (Tas.), Loyetea (Tas.), South Preston (Tas.).

1929. **Form 1**: Cowra, Wagga, Roseville, Werribee (Vic.).
Form 2: Hawkesbury Agricultural College, Mathoura, Cowra, Canowindra, Yanco, Parkes, Gowrie, Bathurst, University of Sydney Plots, Grafton, Glen Innes, Dookie (Vic.), Port Prairie (Vic.), Waite (S.A.).

Form 6: Cowra, Dookie (Vic.).
Form 7: Kentucky, Cowra, Ganmain.

Form 1.—This was recorded in each of the five years dealt with, and was almost certainly present in the material examined during the preceding three years. It was most abundant during 1925. With the exception of Tasmania, all the Australian States and New Zealand yielded cultures of this form. The only material received from Queensland proved to be Form 1. Clearly it is widespread in Australasia.

Form 2.—This was isolated more frequently than any of the other forms, and came to hand from New Zealand and all the States except Queensland. The number of localities represented is also greater than in the case of Form 1. Excepting in 1926 when only three cultures were available for examination, it occurred in each of the seasons dealt with.

Form 6.—Only eight isolations of this form were made. They occurred in 1928 and 1929. The material was collected at four places, three of them in New South Wales and one in Victoria.

Form 7.—This form also occurred only in 1928 and 1929, and was uncommon. The eleven isolations cover material received from three localities in New South Wales and five in Tasmania.

Since the compilation of these results, there has come to hand from Glen Innes, N.S.W., a batch of oaten straw from which Form 3 has been isolated. This makes five naturally-occurring forms of *P. graminis avenae* in Australasia.

In addition to these, at least two forms have been isolated as a result of infecting barberries with teleutospore material collected in Ireland. As tested on the oat rust differentials, one of these gives the reactions for Form 1, and the other for Form 7. Both of these cultures differ markedly in colour from the Australian rusts. A strictly comparative test was made, using cultures on a fully susceptible variety kept under identical conditions. Comparing the colour of the pustules with those given in Ridgway's Colour Standards, all of the Australian forms were "Morocca Red" of Plate i, whilst the Irish rusts were "Xanthine Orange" of Plate iii. This is a very striking difference. There is another significant difference between the Australian Form 1 and the Irish Form 1 when the uredospore measurements are biometrically studied. Furthermore, the Irish rust has shown a remarkable tendency to produce teleutospores on the seedling oats. On varieties which are susceptible, as well as on those which are resistant, abundant teleutosori appear within a month of inoculation as a frequent occurrence. Exactly the same thing is found on grasses, e.g. *Festuca bromoides*, which are susceptible to the rust.

Grasses as Hosts of P. graminis avenae.

In the studies thirty-five isolations of *P. graminis avenae* were made from grasses other than cereals. This does not include isolations from *Avena fatua* or other species of *Avena* which occur as "Wild Oats". These have been very commonly found attacked with stem rust. On account of their near relation to the oats which are cultivated, these isolations from wild oats are not included here, but have been included in those from "oats" already listed.

To date eleven different grasses have been found attacked by oat stem rust. Determinations have shown that three out of the five forms known in Australia

occurred on these grasses. One of these forms has only been found on eight occasions altogether, so it is not surprising that it has not been found on a grass.

The results are shown in the following table:

TABLE 26.
Number of isolations of certain physiologic forms of *P. graminis avenae* made from certain grasses.

Form 1.		Form 2.		Form 3.	
No. of collections.	Grass Host.	No. of collections.	Grass Host.	No. of collections.	Grass Host.
7	*Festuca bromoides*	5	*Festuca bromoides*	1	*Phalaris minor*
2	*Echinopogon ovatus*	1	*Calamagrostis aemula*		
1	*Calamagrostis aemula*	2	*Koehleria cristata*		
1	*Koehleria cristata*	3	*Hordeum murinum*		
1	*Agropyron scabrum*	1	*H. maritimum*		
1	*Hordeum murinum*	3	*Phalaris minor*		
1	*Phalaris minor*	2	*Dactylis glomerata*		
1	*Dactylis glomerata*	1	*Bromus arenarius*		
		1	*Briza minor*		
15		19		1	

Festuca bromoides was found twelve times, sometimes infected with Form 1 and sometimes with Form 2. Extremely heavy infections, involving practically all above-ground parts of the plant, were encountered in the wheat-belt. This particular grass is a worthless introduction and it would be a good thing if the oat rust exterminated more of it. It is notable for its appearance early in the spring. At the time when the oat crop is not far advanced, *Festuca bromoides* is in head and often severely rusted. Infections of the oat crop may thus be initiated by the rust on this grass. With the exception of one isolation from the Waite Institute in South Australia when it was infected with Form 2, all collections examined came from New South Wales.

Phalaris minor showed an even wider degree of infection. All three forms which have been found on grass occurred on this host. In all, five isolations were examined. Each collection came from New South Wales. The collection from which Form 3 was derived was made at the Cowra Experiment Farm. A number of infected plants were gathered at the same time, and from them Forms 2 and 3 were separated out. It is not known whether the two forms were present upon the one plant. At the time of collection, the oat crop in this locality was nearing maturity and was heavily infected with Forms 1, 2 and 3.

Hordeum murinum was found rusted on four occasions. All collections came from New South Wales. Forms 1 and 2 were determined on it. It is a striking

thing that on all four collections the oat rust was associated in the same material with one or two forms of wheat stem rust. When it is remembered that barley grass is most widespread in the wheat belt, and that it occurs early in the season before the wheat and oat crops approach maturity, it will be realized that this host may be important in producing early infections of the crops.

Hordeum maritimum bearing rust was found on only one occasion. It occurred at Cowra, N.S.W., and was infected by both wheat and oat stem-rust.

Koehleria cristata carrying rust was collected three times. Extremely heavy infections with Forms 1 and 2 of oat stem rust were observed. Remarks made concerning *Festuca bromoides* also apply here.

Dactylis glomerata yielded three collections which were either Form 1 or 2. Infections involving the "glumes", as well as the other above-ground parts, have been common. One of the three sets of material came from Tasmania and was of this nature.

Calamagrostis aemula was twice examined and yielded Forms 1 and 2. It falls into the same category as *Festuca bromoides*.

Echinopogon ovatus was twice found in the coastal district of New South Wales infected with Form 1.

Agropyron scabrum collected at Hawkesbury Agricultural College was found to be infected with two forms of *P. graminis tritici* as well as with Form 1 of oat rust.

Bromus arenarius was found only once. It was growing at Cowra and was heavily rusted. In addition to Form 2, one form of *P. graminis tritici* was found on it.

Briza minor was once found infected by stem rust which proved to be Form 2.

Specialization in Puccinia triticina.

Leaf rust occurs frequently in the wheat crops, and takes a heavier toll than is generally recognized. In coastal areas particularly, it often does much damage. Frequently, material of "stem rust" which was submitted was found to consist of a mixture of stem and leaf rusts. Sometimes it was really leaf rust only.

In the earlier years of the work, a number of cultures received from various sources were tested on the standard set of differentials, as well as on a number of other wheats. No indication of specialization was found on these hosts. But in 1926 a culture from Hawkesbury Agricultural College gave an unusual result. The customary thing was to find that Farrer's wheat known as "Thew" was resistant to the leaf rust. In this case the inoculation resulted in a mixture of heavy susceptible pustules together with sharp flecks which, on ageing, produced "1" reactions. A separation of the two was made, and it was clear that a second physiological form had turned up. Thereafter each culture of *P. triticina* that became available was tested on Thew and recorded as Aust. "1" or Aust. "2", depending upon the resistance or susceptibility respectively shown on this host.

There have been striking proofs that these seedling leaf reactions obtained in the plant house are to be directly correlated with the reactions exhibited in the

field. On Plate xxvii are shown illustrations of the upper leaves of wheat varieties grown at Hawkesbury Agricultural College under natural conditions when both forms of rust were present. On Plate xxvii at (*a*) are shown leaves of "Federation" which is susceptible to both forms of leaf rust. On Plate xxvii at (*b*) are illustrated leaves of "Thew". The mixed "4" and "fleck" reactions on these mature leaves are clearly shown. Cultures were made from the susceptible "4" reactions and gave only Form 2. Similar isolations from tiny "1" reactions gave only Form 1. It was found that the same state of affairs existed on "Japanese Bearded" and other varieties which also behave as differentials.

In 1927 Dr. E. B. Mains kindly forwarded grain of his differential hosts. These have been several times tested with the two Australian forms. Several cultures, representing each of the two forms, have been used from time to time. The result is that the reactions of the two forms are identical on this set of differentials. Although separation by these differentials is not possible, it can readily be accomplished by "Thew" and certain other varieties. The series of reactions shown by the Australian rust on Mains' set of differentials is given in the following table alongside those listed by Mains for his Form 12, which most closely, of the twelve forms listed, approximates to ours.

TABLE 27.

Reactions shown by each of the two Australian forms of *P. triticina* on the differential hosts used by Mains and Jackson.

Variety.	C.I. Number.	Each of the Australian Forms.	U.S.A. Form 12.
Malakoff	C.I. 4898–4	;	0
Norka	C.I. 4377–2	;	0
Unnamed	C.I. 3756–4	4	4
,,	C.I. 3778	4	4
Webster	C.I. 3780–8	;	1
Unnamed	C.I. 3747–5	;	0–1
,,	C.I. 3779–5	4	4
Mediterranean	C.I. 3332–3	;	4
Hussar	C.I. 4843–2	4	4
Democrat	C.I. 3384–1	;	4
Kawvale	C.I. 5274–1	1	

These reactions are shown in the same manner as those given by Mains and Jackson (1926). The variety listed as "Turkey 47" has not been available, and an additional one, "Kawvale", was sent by Dr. Mains.

It will be seen that the Australian rust differs from any of the twelve recorded by Dr. Mains. The nearest approach is perhaps to his Form 12, although marked differences occur even here.

Owing to the inability of these hosts to differentiate the Australian forms, it has become the practice since 1926 to test the leaf rusts on "Thew". Prior to that year the tests were not made. The results are summarized in Tables 28 and 29.

TABLE 28.
Results of examination of isolations of *P. triticina* obtained from different sources.

Form No.	Total Number of Isolations.	Different localities in Australian States from which material was collected.				
		New South Wales.	Victoria.	South Australia.	Queensland.	Western Australia.
Period 1926–1927.						
Aust. 1	3	3				
Aust. 2	3	3				
Total ..	6	6				
Period 1927–1928.						
Aust. 1	52	17			1	
Aust. 2	70	19			1	1
Total ..	122	36			2	1
Period 1928–1929.						
Aust. 1	60	25	3	2		
Aust. 2	71	27	3	2	2	
Total ..	131	52	6	4	2	
Totals for the Three Periods.						
	259	94	6	4	4	1

It will be seen that in each of the three years under consideration both forms were present. In the aggregate, Form 2 was a little more abundant than Form 1. So far Form 1 has not turned up in material from Western Australia. From the other States, both forms have been isolated.

The actual localities from which the collections were made are as follows:

Period 1926 – 1927.

Form 1: Hawkesbury Agricultural College, Cowra, Curlewis.
Form 2: Hawkesbury Agricultural College, Wagga.

April, 1927 – March, 1928.

Form 1: Hawkesbury Agricultural College, Cabramatta, Wollongbar, Grafton, Trundle, Cowra, Quandong, Grenfell, Bathurst, Parkville, Warrah Creek, Quaker's Hill, Ben Lomond, Sunnyside, Armidale, Glen Innes, Currabubula, Gatton (Q.).

Form 2: Hawkesbury Agricultural College, Wollongbar, Trangie, Grafton, Griffith, Bathurst, Gowrie, Trundle, Botfield, Cowra, Quandong, Grenfell, Parkville, Warrah Creek, Quaker's Hill, Armidale, Glenfield, Glen Innes, University of Sydney Plots, Gatton (Q.), Chapman (W.A.).

TABLE 29.
Summary of results of examining collections of *P. triticina*.

Form No	Total Number of Isolations.	Period ending March of					
		1927.		1928.		1929.	
		Isolations.	Different Localities.	Isolations.	Different Localities.	Isolations.	Different Localities.
Aust. 1	115	3	3	52	18	60	30
Aust. 2	144	3	3	70	21	71	34
Totals ..	259	6	6	122	39	131	64

April, 1928 – March, 1929.

Form 1: Hawkesbury Agricultural College, Bathurst, Lewis Ponds, Cowra, Boggabri, Trangie, Chatswood, Wagga, Uranquinty, Mumyabla, Coolamon, Coonamble, Berrigan, Brocklesby, Finley, Katoomba, Wollongbar, Corowa, Nyngan, Mathoura, Lockhart, Oaklands, Jindera, Toogong, Rutherglen (Vic.), Werribee (Vic.), Dookie (Vic.), Waite (S.A.), Mallala (S.A.).

Form 2: Hawkesbury Agricultural College, Cowra, Bathurst, Boggabri, Trangie, Pinecliff, Chatswood, Wagga, Grafton, Glenfield, Parkes, Mumyabla, Coolamon, Coonamble, Berrigan, Brocklesby, Finley, Wollongbar, Corowa, Nyngan, Mathoura, Lockhart, Oaklands, Jindera, Toogong, Parkes, Gatton (Q.), Darling Downs (Q.), Rutherglen (Vic.), Dookie (Vic.), Werribee (Vic.), Waite (S.A.), Mallala (S.A.).

OVER-SUMMERING OF RUST.

In the case of annual crops like the cereals, the mode of persistence of pathogens from season to season is a consideration of the utmost importance. Rust is no exception.

In the Northern Hemisphere, many stem-rust studies have been made and much information accumulated. The aecidial stage on the barberry is of the greatest importance in Europe. It has been found that in places where this alternate host has been eradicated, stem rust has diminished or is altogether unknown. In North America there is abundant evidence to show that the aecidial stage is similarly important. At one time it was considered that in the Mississippi Valley, uredospores were capable of overwintering and were important agents in producing the first infections in the spring. More recently it has been stated

(Heald, 1926) that too much emphasis has been placed on overwintering uredospores in that country.

It has already been pointed out (Waterhouse, 1921) that the aecidial stage in Australia has not been found under natural conditions, although it has been artificially produced on numerous occasions. Barberries are not native, and although they have been planted as ornamental shrubs in places, they are not common. A further consideration is that in Australia the wheat crop is sown in the late autumn and early winter and is harvested in the early summer. It is, then, during the hot dry summer season that wheat is not cultivated. Instead of the rust fungus having to "over-winter" as in the Northern Hemisphere, it has here to "over-summer". This does not mean that the teleutospores in Australia could not function as resting spores as they do in the Northern Hemisphere. They remain viable throughout the hot dry summer. In the following late spring and early summer (October may be considered the peak month) they germinate and can infect the barberry. It is at this period when the aecidia may be produced that the uredospore stage is already abundant in the crops. The aecidial stage in the Northern Hemisphere mainly functions in bringing about the early spring infections of the crop. From these are produced the abundant uredosori. It becomes evident that the alternate host in this country is not important and that there must be some means other than by aecidiospores whereby the organism over-summers in Australia.

McAlpine (1906) considers that "volunteer" and second growth wheat probably harbour the uredospore stage of the fungus, and that the organism persists by this means. Evidence bearing upon this was reported by Waterhouse in 1920.

In the present studies, a good deal of further information has been obtained.

Over-summering of P. graminis tritici.

Taking first the case of stem rust of wheat, the following table shows the position.

TABLE 30.
Summary of the number of samples of rusted wheat examined during each month of the period.

Month.	Season of collection, ending March of								Total.
	1922.	1923.	1924.	1925.	1926.	1927.	1928.	1929.	
April					1		8	3	12
May..	1	2					4	4	11
June		1		1		1		8	11
July..	1						6	9	16
August								6	6
September	1				2	1	3	11	18
October	12	1		20	9	17	10	27	96
November	8	3	9	30	8	39	91	66	254
December	7	4	4	35	5	8	43	11	117
January	5	2	7	13		5	15	8	55
February	3	2	3	1	1	4	7	2	23
March	3		2		2	14	2	1	24
Totals ..	41	15	25	100	28	89	189	156	643

The reason for the name "summer rust" being applied to the stem rust becomes at once apparent. November is the month when the rust is most abundant. Regarding the aggregate receipts for the various months, it is seen that samples have come to hand during each month of the year. In the earlier years of the study, but little material was received. The more abundant collections during the last three years are in measure due to valuable assistance rendered by graduates appointed to country districts. The collections for these three years indicate clearly that rust in the uredospore stage is almost certainly present in wheat-growing areas in a viable condition all the year round. The collections which are available under existing conditions are after all very scanty. A wider search would certainly have brought to light many more samples of rust. Since September, 1927, there have beeen only two months when viable uredospore material has not been collected. This clearly points to the fact that the rust persists in the uredospore stage from season to season.

In this connection it should be pointed out that there is a very wide range in the conditions which prevail in the wheat-growing areas of Australia. Having regard solely to the south-eastern portion of the continent, this still applies. Wheat in coastal areas is sometimes sown in March for providing green-feed during the winter. Sowing in other areas continues throughout the ensuing months as late as July. Similarly there is a continuity in the harvesting operations. Early crops for hay may be taken off in October, and harvesting operations are in progress right through until even February in late districts. This means a great difference in the development and the amount of "volunteer" wheat—both "second-growth" and "self-sown"—which is present in paddocks in the various districts.

Apart altogether from this occurrence of stem rust in different districts, evidence is not wanting that in a particular area, rust is present on volunteer wheat throughout the year when conditions are favourable. Mr. R. E. Dwyer of Bathurst kindly undertook a search at the Bathurst Experiment Farm. In February, 1927, a first collection was forwarded, and thereafter until April, 1928, in each month, with one exception (August, 1927), rusted wheat straw carrying viable uredospores of *P. graminis tritici* was forwarded. The absence of the collection in the one month of August may well have been due to the pressure of other duties limiting the search.

In any case six other collections from different New South Wales localities came to hand during that month. Some of these were on volunteer wheat, others on the growing crop, young as it was at that time. It was very striking to see heavy stem-rust infections of the leaves of seedlings collected in the paddocks.

At Hawkesbury Agricultural College a series of collections points to the same state of affairs. Mr. T. H. Harrison has forwarded very many specimens from time to time, and though there are gaps in the monthly sequence, there would seem little doubt about the presence of viable uredospores on volunteer wheat the year round.

There is a practical bearing to this persistence of the uredospore stage on volunteer wheat. Ordinary cultivation methods cannot be expected to eliminate it, for the cultural practices at the Bathurst Experiment Farm and Hawkesbury Agricultural College, for example, are good. Whilst viable uredospores are present in the wheat areas there will be the possibility of epidemics of rust in

favourable seasons so long as susceptible varieties of wheat are grown. Safety in "muggy" seasons lies in the growing of varieties which are resistant to rust.

Over-summering of P. graminis avenae.

The results of the studies of this organism are summarized in the following table:

TABLE 31.

Summary of the numbers of samples of rusted oats examined during each month of the period.

Month.	Season of collection, ending March of								Total.
	1922.	1923.	1924.	1925.	1926.	1927.	1928.	1929.	
April							3	1	4
May							2	2	4
June						1			1
July	1			2				3	6
August								2	2
September	1							3	4
October	5		1	5			1	5	17
November	1		1	11	1	14	17	28	73
December	2			11		3	11	3	30
January	1		2			1	7	2	13
February			1	1	1	1	2		6
March					1	1	4		6
Totals ..	11		5	30	3	21	47	49	166

In the aggregate, the relative abundance of oat stem-rust in the various months throughout the year approximates closely to that shown by the wheat stem-rust. Although fewer isolations were available, they indicate clearly that stem rust of oats is most abundant in the summer, but it is nevertheless present on "volunteer" oats throughout the year when the crop is not being grown. An intensive search would almost certainly reveal the presence of abundant viable material continuously throughout a year. The widespread occurrence of "wild oats" is a further important factor in the case.

Over-Summering of P. triticina.

The results of the collections are summarized in Table 32.

Here again it appears that November is the "peak" month. But it is clear that, as early as September, the rust is abundant. Actually the occurrence of the peak in November is probably misleading. It should occur earlier. The studies herein reported have dealt primarily with stem rust. Collections forwarded from country centres have been, in the main, stem rust, and have been made because this particular rust has been present. The occurrence of leaf rust on the flag earlier in the season has not resulted in field workers forwarding specimens. Whenever leaf rust has been present on material in addition to stem rust, it has been cultured and subjected to study.

The indications are clear that leaf rust is also present on volunteer wheat the whole year round.

TABLE 32.

Summary of the numbers of samples of rusted wheat examined during each of the months of the period.

Month.	Season of collection, ending March of								Total.
	1922.	1923.	1924.	1925.	1926.	1927.	1928.	1929.	
April								4	4
May	2						1	5	8
June							2	9	11
July							1	11	12
August								17	17
September	1		1				2	41	45
October	6					1	16	23	46
November	3					2	75	16	96
December	1						15	4	20
January	1							1	2
February						1			1
March	1					2			3
Totals ..	15		1			6	112	131	265

SUMMARY AND CONCLUSIONS.

1. Studies of various graminaceous rusts have been in progress for several years. Stem rusts have received main attention, and of these, stem rust of wheat has had most time devoted to it.
2. Work with the aecidial stage of *Puccinia graminis* further disproved the old statement that stem rust of wheat in Australia has lost its power of attacking the barberry. Many successful infections were obtained from Australian teleutospores, as well as from material received from overseas. It appears that Form 43 of *P. graminis tritici* is incapable of successfully infecting the barberry. Further indirect evidence was obtained that change in the specialization of a rust may be brought about in the aecidial stage on the barberry. The teleutospores received from overseas have given rise to physiologic forms of *P. graminis tritici* and *P. graminis avenae* which are unlike those occurring in Australia.
3. Germination studies were made of teleutospores naturally occurring on straw which had been exposed throughout the winter to weather conditions. The most abundant germinations occur about October, but sparse germinations are found as early as March. Between March and October germinations are sporadic, and they cease altogether in November. There was no discernible difference between the germination capacity of teleutospores of different physiologic forms.
4. Uredospore studies have involved questions of specialization. Tests of the grain of varieties used as differential hosts have shown that steps must be continuously taken to maintain the purity of these plants.

5. It was found that variations in the environmental conditions in the plant house may profoundly influence the reactions of differential hosts to various rusts.
6. In the case of *P. graminis tritici* there was change from complete susceptibility in the hotter months to complete resistance in the cooler part of the year. The reactions on several of the differential hosts showed this change. Some physiologic forms show much more violent alterations of this nature than do others.
7. Changes from summer to winter conditions alter the reactions shown by *P. graminis avenae* 1 on "Joanette" from complete susceptibility to complete resistance.
8. Tests with cultures of *P. triticina* showed that the reactions it gives on certain varieties of wheat are changed by altering the environmental conditions.
9. Essentially similar results are shown by *P. simplex* on certain varieties of barley.
10. Such major variations in the reactions given on differential hosts may completely alter determinations of the physiologic specialization of the fungus concerned. In field practice such changes may also be of the utmost importance.
11. But under identical conditions of cultivation, physiologic forms may be sorted out upon the basis of their rust reactions on selected hosts.
12. In Australasia, seven naturally occurring forms of *P. graminis tritici* have been found by this means. They are Forms 34, 43, 44, 45, 46, 54 and 55. Form 11, a form tentatively designated Form 45A, and a hitherto unrecorded form have been obtained from the aecidial stages on barberries. Two other forms —16 and 27—have similarly been produced from overseas teleutospore material.
13. The distribution of these naturally occurring forms has been studied in regard to time and space.
14. Prior to 1926, Forms 43, 44, 45, 46, 54 and 55 were present, but in 1926, Form 34 was found in Western Australia. Next year it occurred in the Eastern States, and at the present time it appears to be the only form which occurs in Australasia.
15. *P. graminis tritici* is most abundant in wheat crops about November, but investigations have shown that it has been present in the viable uredospore stage on volunteer wheat and other hosts all the year round.
16. Barley serves as a host for various forms of *P. graminis tritici*, as does also rye. On the latter crop, there has been no indication of the presence of *P. graminis secalis.*
17. Several grasses have been found to be natural hosts for various forms of *P. graminis tritici. Hordeum murinum* and *Agropyron scabrum* are outstanding examples.
18. Specialization studies of *P. graminis avenae* have shown the presence in Australasia of Forms 1, 2, 3, 6 and 7. Cultures of the organism have also been obtained from the aecidial stage produced by rust sent from Ireland.
19. The distribution of *P. graminis avenae* has been studied, as has also its natural occurrence on grasses. *Festuca bromoides, Phalaris minor,* and *Hordeum murinum* are outstanding hosts of various forms of the rust.

20. A number of other grasses have been tested in the plant house, mainly in the seedling stage, with various cultures of the available rusts, and their reactions recorded.

21. Specialization studies of *P. triticina* have shown that the differential hosts used by Mains and Jackson do not differentiate the Australian leaf rusts. But this is readily accomplished by "Thew". The two physiologic forms thus sorted out have been studied in their distribution and in their host range on grasses.

22. Studies of the incidence of rust have shown that over-summering of the uredospore stage occurs in Australia. This applies to the stem rusts of wheat and oats and to leaf rust of wheat.

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EXPLANATION OF PLATES XXIV–XXVII.

Plate xxiv.

(*a*). Aecidial stage of *P. graminis avenae* on a barberry produced by inoculations with oaten straw from Ireland.

(*b*). Natural crossing in a variety of *Triticum sphaerococcum.* In the top row at the left is shown a normal ear of the variety as received from England. In the top row at the right is an ear of the wheat derived from the grain grown at Cambridge, England. In the bottom row are typical ears of some of the wheats derived as segregates from the last-mentioned wheat, illustrated in the right of the top row.

Plate xxv.

Under surface of seedling leaves of wheat showing types of reaction produced by *P. graminis tritici.*

(*a*). Leaves showing the flecks of the immune type designated "0;" of the resistant class.

(*b*). Leaves showing the very resistant or "1" type of reaction belonging to the resistant class.

(*c*). Leaves showing the moderately resistant or "2" type of reaction belonging to the resistant class.

(*d*). Leaves showing the relatively susceptible or "3" type of reaction belonging to the susceptible class.

(*e*). Leaves showing the completely susceptible or "4" type of reaction belonging to the susceptible class.

(*f*). Leaves showing the intermediately susceptible or "X" type of reaction belonging to the indeterminate class.

(*g*). Leaf of Mindum showing flecks produced by Form 34 in winter test.

(*h*). Leaf of Mindum showing the completely susceptible "4" reaction produced by Form 34 in summer test.

Plate xxvi.

Variations in the reactions shown under different environmental conditions.

(*a*), (*b*) and (*c*). Seedling leaves of "Joanette" oats infected by the same culture of *P. graminis avenae* I.

(*a*). The very resistant or "1" type of reaction exhibited in the winter.

(*b*). The indeterminate or "X" type of reaction exhibited in the late spring and autumn.

(*c*). The completely susceptible or "4" type of reaction found in the summer.

(*d*) and (*e*). Two upper and two lower surfaces of the leaves of "Khapli" infected by Form 27 of *P. graminis tritici*. In (*d*) are shown the very resistant reactions normally shown, and in (*e*) the susceptible reactions found in the spring and autumn.

Plate xxvii.

Infections of wheat by *P. triticina*.

(*a*) and (*b*) illustrate leaves naturally occurring at Hawkesbury Agricultural College. In (*a*) are shown leaves of "Federation" on which pustules of both forms of leaf rust are present. In (*b*) are shown the mixtures of susceptible or "4" pustules of one form, and the flecks of the other form on leaves of "Thew".

(*c*), (*d*) and (*e*). Under surfaces of seedling leaves of wheat showing the results obtained in the plant house. (*c*) illustrates the flecks of the immune type of reaction, (*d*) shows the moderately resistant or "2" type of reaction belonging to the resistant class, and (*e*) shows the completely susceptible or "4" type of reaction belonging to the susceptible class.

A FURTHER CONTRIBUTION TO OUR KNOWLEDGE OF THE FLORA OF NEW SOUTH WALES.

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(Plates xxviii-xxx.)

[Read 27th November, 1929.]

Synopsis.

Correa macrocalyx, n. sp.	Rutaceae.
Bertya oblonga, n. sp.	Euphorbiaceae.
Lasiopetalum Joyceae, n. sp.	Sterculiaceae.
Kunzea rupestris, n. sp.	Myrtaceae.
Prostanthera Howellae, n. sp.	Labiatae.
Goodenia Chisholmi, n. sp.	Goodeniaceae.

Family Rutaceae.

Correa macrocalyx, n. sp. Plate xxviii.

Frutex lano-ramosus sempervirens, 3–12 pedes altus; rami et laminae dorsales foliorum infectae cinereo vel leviter ferrugineo stellato-tomentoso tegumento; folia opposita, breviter petiolata, cordata vel elliptica, minute denticulata, 4–10 × 3–7 cm.; flores deflexi, singuli vel pares, pedunculus tenuibus, axillares vel terminales, 2·5 cm. longi; calyx cupularis, 9–10 mm. longus; corolla viridi-flava, 15–18 × 5 mm.; dense hirsuta pilis depressis; filamenta basi leviter dilatata, corollam 10–12 mm. supereminentia; capsula depresso-globularis, 15 × 13 mm.

A loosely-branched evergreen shrub 3–12 feet high, sometimes growing with a single stem, but usually producing several slender stems from a woody rootstock; branches and underside of leaves covered with a hoary or slightly ferruginous, stellate tomentum. Leaves opposite, thin, shortly petiolate, cordate or elliptical, minutely and irregularly denticulate, 4–10 × 3–7 cm., dark green and shining above, hoary or ferruginous-stellate beneath; venation moderately distinct and rather distant, the midrib very conspicuous beneath; oil dots very numerous. Flowers deflexed or nodding, single or in pairs, on slender axillary or terminal peduncles, 2·5 cm. long. Calyx cupular to somewhat cylindric, truncate or sinuolate, green or reddish at the base, more or less minutely stellate-tomentose, 7–10 mm. long. Corolla cylindrical, densely hirsute with short, depressed hairs, greenish-yellow, 15–18 × 5 mm., the short, incurved, obtuse lobes unequal. Filaments cream-coloured, all more or less slightly dilated towards the base, exceeding the corolla by 10–15 mm.; anthers rather large, versatile. Style filiform, scarcely as thick as the filaments; stigma small, capitate. Capsule depressed globular, 15 × 13 mm., hirsute, becoming glabrous with age, separating elastically into four two-celled, transversely rugose, venulose carpels. Seeds oblong-reniform to ovate, glossy, lead-coloured, smooth or slightly muricate, 4–5 × 1·5–2 mm. Hilum lateral, forming a deep U-shaped scar; testa shell-like but moderately hard.

Range.—So far it has only been found at Patonga, Hawkesbury River, New South Wales (D. W. C. Shiress and W.F.B., October, 1923). At one spot of about two acres it is in basaltic soil, and in another place of about the same area it is in deep, rather rich, sandy soil. At the latter place it is subjected to frequent bush-fires and forms dense thickets 3–4 feet high, and wherever cattle have access to it they keep it closely cropped off.

Near *C. Lawrenciana*, but differing in the broader and more orbicular, obtuse leaves, larger calyx, different vestiture of the corolla, and longer filaments.

It is readily distinguished from *C. speciosa* var. *virens* by the very broad cordate leaves, much larger calyx, in the hirsute corolla and in the more distinctly uniform filaments.

Family Euphorbiaceae.

Bertya oblonga, n. sp. Plate xxix.

Frutex subresinosus pluricaulinus, 3–6 pedes altus, ramis erectis virgatis subcinereis teretibus; stirpes juveniles subaureae minuta stellata pubescentia; folia alterna, petiolata, lineari-oblongi, obtusa, marginibus revolutis, 1–2 cm. longa, 3–4 mm. lata, superne glabra, inferne tomentosa; flores plerumque solitarii, axillares vel terminales in ramellis abbreviatis insidentes; perianthus masculinus feminina major; sepalis glabris, petalloideis, bracteis deciduis longioribus; staminae numerosae, in columnam conicam unitae; perianthus femininus minutus; bracteae longae; sepalae glabrae, lineares, acutae; ovarium dense stellato-pubescens, 8 × 4–5 mm.; semina glabra, nitido-brunnea, 5 × 3 mm.

A subresinous, many-stemmed, slender shrub, 3–6 feet high, with erect, virgate, terete, somewhat hoary branches, the young tips slightly golden with a minute stellate pubescence. Leaves alternate, petiolate, erect or spreading, linear-oblong, obtuse, with revolute margins, channelled and glabrous above, pale and very closely tomentose beneath, 1–2 cm. long, 3–4 mm. broad, the midrib very prominent on the lower surface. Flowers pedicellate, usually solitary, axillary, but frequently terminal on the abbreviated shoots. Male perianth larger than the female; bracts rather thick, linear, keeled, usually unequal and more or less hoary, shorter than the calyx. Sepals glabrous, broad, petal-like, greenish-white, undulate and recurved at the top, more than twice the length of the deciduous bracts. Stamens numerous, united into a cone-like column. Female perianth very small; bracts hoary, obtuse, unequal. Sepals glabrous, pale brown, shining, linear, acute, expanded under the fruit; ovary densely stellate-pubescent as in *B. rosmarinifolia*. Styles glabrous, irregularly 3-branched, moderately persistent on the fruit. Capsule oval-oblong, somewhat acute, sparingly stellate-tomentose or nearly glabrous, 8 × 4–5 mm. Seeds smooth, glossy-brown, with a small, white, rugose caruncle, 5 × 3 mm.

Range.—Pinecliffe, about 1,760 feet above sea-level, and 21 miles south-west from Molong, N.S.W. (W. F. Blakely, November, 1907).

Its position is near *B. rosmarinifolia*, from which it may be separated by the broader and shorter leaves, terminal inflorescence, narrower and more acuminate sepals, and almost glabrous capsules.

Family Sterculiaceae.

Lasiopetalum Joyceae, n.sp. Plate xxx, figs. 8, 9.

Frutex tenuis, 3–6 pedes altus, ramis virgatis divergentibus; folia angusto-oblonga vel admordum spathulata, breviter petiolata, plerumque deflexa, 3–12 × 0·5–1

cm.; racemi axillaris, 2–4 floribus; pedicelli filiformes, 4–7 mm. longi; calyx roseo-vel rubro-fulvus, 14 × 11 mm., extus tomentosus; corolla petalis minutis cordatis; filamenta tenuia, antheris apiculatis breviora; ovarium stellato-tomentosum; bracteoli lineares, 5–8 mm. longi, approximati sed non adnati ad calycem; capsula subglabra.

A slender shrub, 3–6 feet high, with virgate, spreading branches. Leaves narrow-oblong to oblong-lanceolate, or somewhat spathulate, shortly petiolate, 3–12 × 0·5–1 cm., dark green and glabrous above, pale and somewhat rusty-tomentose beneath. Racemes axillary, rather slender, 2–4-flowered. Pedicels almost filiform, 4–7 mm. long. Bracteoles linear, 5–8 mm. long, very close to the calyx, but not adnate. Calyx flesh-coloured to reddish-brown, up to 14 × 11 mm., the lobes undulate and united for half their length, forming five hollow, pouch-like projections at the base, tomentose outside and partly so within, or the broad inner margins almost glabrous. Petals minute, cordate, with a tuft of hairs down the centre. Filaments slender, shorter than the oblong, apiculate stamens. Ovary tomentose. Capsule subglabrous.

Range.—Mount Colah to Bobbin Head (Joyce Blakely, September, 1915); junction of Kuring-gai Creek and Connelly's Creek (D. W. C. Shiress and W.F.B., September, 1920); about half-way between Berowra and Cowan on the west side of the railway line (same collectors, October, 1925), the type.

Named in memory of my late adopted daughter, Joyce, who was the first to bring this beautiful species under my notice.

It is one of the most attractive of the eastern species and is closely allied to *L. rufum*, from which it differs greatly in size and habit, also in the larger and broader leaves, and in the flowers being more than twice the size of those of its ally. The bracteoles are also larger and broader than those of *L. rufum*, and are closer to the calyx.

Family Myrtaceae.

Kunzea rupestris, n. sp. Plate xxix.

Frutex vagans, ramis dense confertis, 2–4 pedes altus; rami juveniles et bases foliorum lanati; folia sessilia aut breviter petiolata, alterna, saepe conferta, lineari-lanceolata, inconspicue trinervia, 7–12 × 2–3 mm.; flores candidi, breviter pedicellati, in captibus densis terminalibus, 1–1·5 cm. diametro; bracteae subulatae, villosae; calyx turbinatus, 5-costatus, tomentosus, sepalis subulatis; petalae triangulares, vix sepalas excedentes; filamenta numerosa; antherae reniformes; stylus filiformis, 5–7 mm. longus; stigma minutum. Fructus nondum visi.

A densely branched, straggling shrub 2–4 feet high, up to 6 feet in diameter. Young branches and leaf bases woolly-tomentose. Leaves sessile to shortly petiolate, alternate, usually densely clustered, linear-lanceolate, faintly trinerved, 7–12 × 2–3 mm. Flowers white, shortly pedicellate in dense terminal heads, 1–1·5 cm. in diameter. Bracts subulate, subscarious, villose, shorter than the flowers. Calyx turbinate, 3–4 mm. long, five-ribbed, densely tomentose with short, white hairs. Sepals subulate, 2 mm. long. Petals white or tinged with pink, triangular, scarcely exceeding the sepals. Filaments numerous; anthers small, reniform. Style filiform, 5–7 mm. long; stigma minute. Fruit not seen.

Range.—Growing on bare sandstone rocks about one mile north-east of Colo Trigonometrical Station, 861 feet above sea-level, and just below the Canoe Grounds, Hawkesbury River (D. W. C. Shiress and W.F.B., October, 1927).

It has much in common with *K. bracteata*, but differs in habit, also in the larger, faintly-trinerved leaves, more numerous flowers in the head, in the densely villose, turbinate calyx, narrower and smaller subulate sepals, smaller petals, and in the subulate woolly bracts.

Family Labiatae.

Prostanthera Howellae, n. sp.

Frutex tenuior, virgatus, scabrosus, 2–5 pedes altus; folia opposita, brevi-petiolata, obtusa, marginibus scabrosis revolutis, 3–5 × 1–2 mm.; flores axillares, obscuro-violacei, plerumque solitarii, pedicellis tenuibus longitudine fere calycem aequantibus; bracteolae lineares, subfoliaceae, ad basior tubi calycis adnatae; calyx scabro-hispidus, 7–10 nervis, labris inaequantibus; corolla bis longior quam calyx, extus leviter hispida intus omnino glabra; antherae obscure violaceae, sini appendiculis; semini oblique ovata, rugosa, 3–4 nervis longitudinalibus, inconspiceis, hilo subtruncato.

A slender, virgate, scabrous shrub, 2–5 feet high. Leaves opposite, very shortly petiolate, lanceolate, obtuse, with somewhat minutely hispid, revolute margins, 3–5 × 1–2 mm. Flowers axillary, deep violet, usually solitary on slender, terete pedicels nearly as long as the calyx. Bracteoles linear, subfoliaceous or similar to the upper leaves, inserted on the base of the calyx-tube. Calyx scabrous-hispid, with short, rigid white setae, interspersed with lenticular-like glands, 7–10-nerved, the lips unequal, broad and obtuse; lower lip much smaller than the upper, concave, ciliate; upper lip quite glabrous on top, with a ring of soft white hairs about three millimetres below the glabrous portion. Corolla twice the size of the calyx, slightly hispid externally, glabrous within. Anthers dark violet, without any appendages. Seeds four, obliquely ovate, rugose, faintly-nerved; hilum small, subtruncate.

Range.—In hard sandstone gravelly soil between Sackville Reach and Maroota (Mr. and Mrs. T. J. Howell and W.F.B., September, 1927); in somewhat similar soil at Glenorie and also on the Canoe Grounds near Colo Trigonometrical Station, 861 feet above sea-level (D. W. C. Shiress and W.F.B., 14th October, 1927); between the Lane Cove River and Gordon (C. T. White and W.F.B., 28th November, 1927).

Named in honour of Mrs. T. J. Howell, who, for a number of years, has taken a keen interest in the native flora.

Closely allied to *P. marifolia*, from which it may be distinguished by its taller and more virgate habit, narrower leaves, larger flowers, in the more unequal calyx-lobes which are bordered by soft white hairs, and in the larger anthers without appendages. The bracteoles are also attached to the base of the calyx, and not to the pedicel, as in *P. marifolia*.

Family Goodeniaceae.

Undersection Bracteolatae.

Goodenia Chisholmi, n. sp. Plate xxx, figs. 1-7.

Parvus frutex tomento stellato indutus; rami teretes; folia breviter petiolata, plana, lanceolata, integra vel minute dentate, 4–6 × 1–2 cm.; pedunculi axillares singulum florem gerentes, breviores quam folia; bracteoli lineari-lanceolati; lobi calyces acuminati 5 mm. longa; corolla extrinsecus stellata, 1·5 cm. longa, barbata intrinsecus longis setis deflexis; stylus pilosus; capsula ovata; semina oblongo-ovata levia, 4 mm. longa, 2·5 mm. lata.

An erect, softly stellate undershrub, 3–4 feet high, with terete branches. Leaves shortly petiolate, flat or with slightly revolute margins, lanceolate, entire or minutely dentate, 4–6 × 1–2 cm. Peduncles axillary, 1-flowered, shorter than the leaves. Bracteoles linear-lanceolate, 2–3 mm. from the flower. Calyx-lobes linear, acuminate, 5 mm. long. Corolla pink or pale purple, stellate outside, 1·5 cm. long, barbed inside with long, deflexed, white bristles, the lobes deeply divided and with membranous margins. Style pilose, with long white hairs. Capsules ovate, 1–2-seeded; seeds oblong-ovate, pale brown, smooth and shining, about 4 × 2·5 mm.

Range.—"Occupying a small area on the eastern slopes of the Comboyne Plateau, growing amongst hardwoods at the edge of the brush on mixed formation, mostly sedimentary rock with possibly a slight mixture of basalt" (Dr. E. C. Chisholm, January, 1925); Kendall (F. M. Bailey, September, 1929).

It is closely allied to *G. barbata*, from which it may be distinguished by the larger and broader leaves, different vestiture and larger flowers.

Named in honour of Dr. E. C. Chisholm, who has taken a keen interest in the flora and fauna of the Comboyne.

I desire to offer special thanks to Miss Margaret Flockton, Artist, for her valuable assistance in many of the analytical drawings.

EXPLANATION OF PLATES XXVIII–XXX.

Plate xxviii.

Correa macrocalyx Blakely.

1.—Portion of branch showing (*a*) under side of leaf, (*b*) upper side of leaf. 2.—Flower, slightly enlarged. 3.—Capsule, × $\frac{5}{8}$. 4.—Ground plan of capsule. 5.—Seed, × $\frac{5}{8}$.

Plate xxix.

1. *Bertya oblonga* Blakely.

A.—Fruiting twig, natural size. B.—Back view of leaf, greatly enlarged. C.—Male perianth, enlarged. D.—Female perianth, enlarged. E.—Fruit, enlarged. F.—Seed, enlarged.

2. *Kunzea rupestris* Blakely.

A.—Flowering twig, natural size. B. and C.—Front and back views of leaf, enlarged. D.—Flower, greatly enlarged. E.—Floral bracts. F.—Petal, enlarged.

Plate xxx.

Goodenia Chisholmi Blakely.

1.—Portion of flowering branch, × $\frac{5}{8}$, showing (*a*) upper surface of leaf, (*b*) under surface of leaf. 2.—Front view of flower opened out. 3.—Back view of flower. 4.—Style, greatly enlarged. 5.—Back view of calyx and two bracteoles. 6.—Fruiting calyx, enlarged. 7.—Seed, enlarged.

Lasiopetalum Joyceae Blakely.

8.—Portion of flowering branch, × $\frac{5}{8}$. 9.—Details of flower, calyx removed, showing the rudimentary petals, five stamens and the stellate ovary.

LIST OF PAPERS BY THE LATE J. J. FLETCHER.*

1881.

On the condition of the median portion of the vaginal apparatus in the Macropodidae. *Proc. Zool. Soc. Lond.*, 1881, 976-996. (*With J. J. Lister.*)

1882.

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1883.

On some points in the anatomy of the urogenital organs in females of certain species of Kangaroos. i. Proc. Linn. Soc. N.S.W., vii, 1882 (1883), 640-659.

On some points in the anatomy of the urogenital organs in females of certain species of Kangaroos. ii. Proc. Linn. Soc. N.S.W., viii, 1883, 6-11.

Note on a Viviparous Lizard (*Hinulia elegans*). Proc. Linn. Soc. N.S.W., viii, 1883, 215-217.

1884.

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1886.

Notes on Australian Earthworms. i. Proc. Linn. Soc. N.S.W., (II) i, 1886, 523-574.

Notes on Australian Earthworms. ii. Proc. Linn. Soc. N.S.W., (II) i, 1886, 943-973.

1887.

Notes on Australian Earthworms. iii. Proc. Linn. Soc. N.S.W., (II) ii, 1887, 375-402.

Notes on Australian Earthworms. iv. Proc. Linn. Soc. N.S.W., (II) ii, 1887, 601-620.

Remarks on an introduced species of Land-Planarian, apparently *Bipalium kewense*, Moseley. Proc. Linn. Soc. N.S.W., (II) ii, 1887, 244-249.

Notes on Australian Land-Planarians, with descriptions of some new species. i. Proc. Linn. Soc. N.S.W., (II) ii, 1887, 349-374. (*With A. G. Hamilton.*)

1889.

Notes on Australian Earthworms. v. Proc. Linn. Soc. N.S.W., (II) iii, 1888 (1889), 1521-1558.

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Notes on Australian Earthworms. vi. Proc. Linn. Soc. N.S.W., (II) iv, 1889 (1890), 987-1019.

Additional notes on *Peripatus leuckartii*. Proc. Linn. Soc. N.S.W., (II) v, 1890, 469-486.

1891.

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Contributions to a more exact knowledge of the geographical distribution of Australian Batrachia. ii. Proc. Linn. Soc. N.S.W., (II) vi, 1891, 263-274.

Description of a supposed new Cystignathoid Frog. Proc. Linn. Soc. N.S.W., (II) vi, 1891, 275-276.

1892.

Contributions to a more exact knowledge of the geographical distribution of Australian Batrachia. iii. Proc. Linn. Soc. N.S.W., (II) vii, 1892, 7-19.

A viviparous Australian *Peripatus* (*P. leuckartii*, Sang.). Proc. Linn. Soc. N.S.W., (II) vii, 1892, 179-196.

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* This list, together with pages xxxiii-xlii of the Proceedings for 1927, is to be included in the Memorial Series.

1894.

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1896.

On the dates of publication of the early volumes of the Society's Proceedings. Proc. Linn. Soc. N.S.W., (II) x, 1895 (1896), 533-536.

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1898.

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1909.

Illustrations of Polycotyledony in the genus *Persoonia*, with some reference to *Nuytsia* (N.O.O. Proteaceae; Loranthaceae). Proc. Linn. Soc. N.S.W., xxxiii, 1908 (1909), 867-882.

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On certain shoot-bearing tumours of Eucalypts and Angophoras: and their modifying influence on the natural growth-habit of the plants. Proc. Linn. Soc. N.S.W., xliii, 1918, 191-233. (*With C. T. Musson.*)

1920.

Presidential Address delivered at the Annual General Meeting on 31st March, 1920. Proc. Linn. Soc. N.S.W., xlv, 1920, 1-47. (On the correct interpretation of the so-called phyllodes of the Australian phyllodineous Acacias, pp. 24-47.)

1921.

The Society's Heritage from the Macleays. i. Proc. Linn. Soc. N.S.W., xlv, 1920 (1921), 567-636.

Presidential Address delivered at the Annual General Meeting on 30th March, 1921. Proc. Linn. Soc. N.S.W., xlvi, 1921, 1-14.

1927.

On a case of natural hybridism in the genus *Grevillea* (N. O. Proteaceae). Proc. Linn. Soc. N.S.W., lii, 1927, 122-132. (*With C. T. Musson.*)

1929.

The Society's Heritage from the Macleays. ii. Proc. Linn. Soc. N.S.W., liv, 1929, 185-272.

ON SOME RECENT NEW LIGHT ON THE ORIGIN OF MAMMALS.

By R. Broom, M.D., D.Sc., F.R.S.,
Corresponding Member.

(Seven Text-figures.)

[Read 27th November, 1929.]

It is nearly thirty-five years since the Linnean Society of New South Wales published some of my first papers dealing with the comparative anatomy of the Marsupials and Monotremes and thus gave me an introduction to the scientific world. The work started in Australia in 1895 has been for the last thirty years carried on in South Africa and has had for its main object the solution of the problem of the Origin of Mammals. And as I have never forgotten what I owe to the Linnean Society I should like to give it a short report on the present position of the problem.

From 1880 to 1890 most scientists believed with Huxley that mammals had descended from amphibians, though a few, impressed by the mammal-like characters of the Permian reptiles of America and South Africa, considered that more probably the mammals arose from these mammal-like reptiles, and this latter was the opinion of Cope and Owen.

In 1889 Seeley visited South Africa and discovered a number of new types of mammal-like reptiles, some much more mammal-like than any that had been previously known. Yet even these discoveries did not seem to convince most, and Seeley himself regarded these reptiles as only resembling mammals by a parallel development and only related to mammals in having had a common ancestor, perhaps as far back as Devonian times.

Osborn, however, in 1897 and 1898 expressed his belief that the mammals had descended directly from some mammal-like reptile.

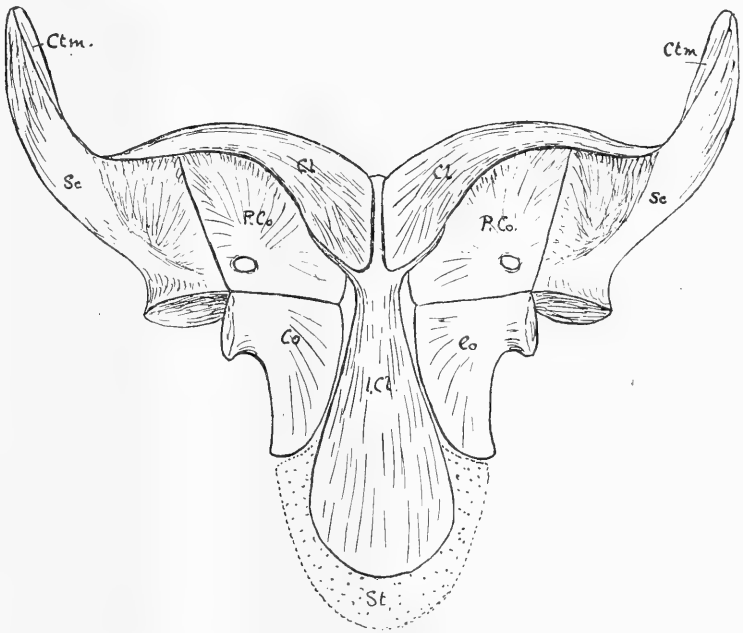
When I came to South Africa in 1897, very little was known of the structure of any of the mammal-like reptiles, and, if Seeley's classification of 1895 be examined, it will be seen how very unsatisfactory the whole position was. *Pareiasaurus* and *Procolophon* were regarded as mammal-like reptiles, and so were the Placodonts; and the Dicynodonts were considered to be very dissimilar in structure to the carnivorous Cynodonts.

Though I came to South Africa in 1897 I had no chance of seeing more than half a dozen specimens till 1900, when I went to Pearston in the Karroo, and was able to collect for myself. Very soon I discovered that the Dicynodonts, though superficially very unlike the carnivorous type, are really closely allied. And in one of my early papers (1901) I showed that most reptiles can be grouped in one of two large subdivisions—the one including the mammal-like reptiles and leading to the mammals: the other, the *Sphenodon*-like forms, leading to birds. This subdivision was more fully elaborated by Osborn in 1902 and he gave the

names Synapsida and Diapsida to the divisions. Seeley's discoveries had shown that there were various forms of carnivorous mammal-like reptiles, but too little was known of the anatomy of any of them to make any classification satisfactory. In 1903 I discovered that the lower Theriodonts have a palate essentially like that of *Sphenodon* and thus quite different from that in the higher Theriodonts or Cynodonts discovered by Seeley, and I proposed the name Therocephalia for these lower forms.

Every year new forms were found, and gradually almost all details of the structure of the various groups became known.

In 1909 a new type of Cynodont-like reptile was discovered which I called *Bauria*, after the famous American palaeontologist. Some years later Watson separated this and a number of allied forms into a distinct suborder Bauriamorpha.



Text-fig. 1.—Therocephalian Shoulder Girdle.
Shoulder girdle of *Pristerognathus minor* (Htn.), reduced.
The sternum remains cartilaginous.

In 1913 for the first time the structure of the skull in *Gorgonops* and its allies was understood and Seeley's suborder Gorgonopsia was seen to be a good one, though the character on which Seeley had founded it was incorrect.

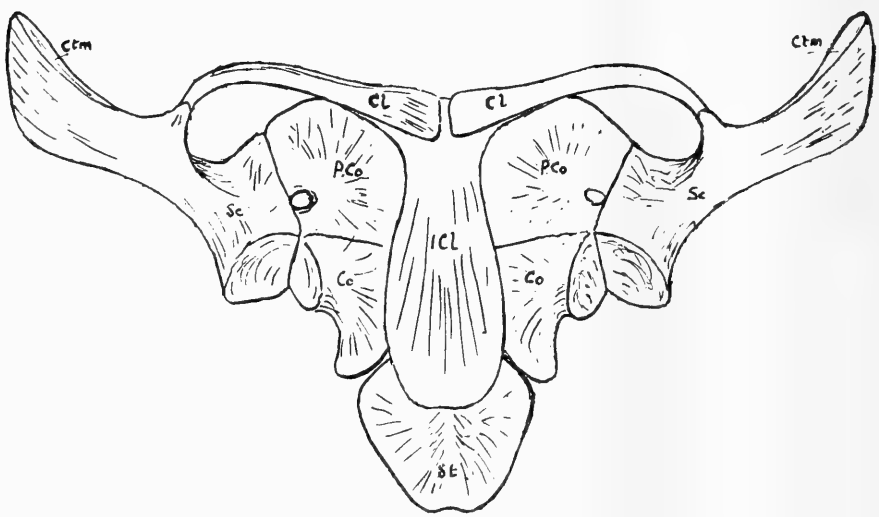
In 1907, and more fully in 1914, the Dromasauria became known. This is a group of small either primitive or possibly degenerate mammal-like reptiles.

In 1923 the skull, and in 1929 the skeleton, of the large mammal-like reptiles of the primitive order Dinocephalia first became moderately well known; and in 1923 was described the only known member of the suborder Burnetiamorpha—possibly a highly specialized offshoot of the Gorgonopsians.

Notwithstanding the large numbers of types of the mammal-like reptiles or Therapsida belonging to many different orders and suborders, it was a matter of great difficulty to say just where the mammals had been given off.

The Cynodonts are so very like mammals in many ways that most were inclined to think the ancestral mammal might have been a Cynodont. The teeth are arranged, as in mammals, into incisors, canines, premolars and molars, and there appear to have been two sets of incisors, canines and premolars just as in mammals. And though the mandible was still attached to the skull by an articular-quadrate joint, the dentary was very large and in some forms almost articulate with the squamosal. Still there were difficulties—the most serious being that the secondary palate is apparently supported by a prevomer and not by a true vomer as in mammals, the true vomer being small and far back.

For a time I was inclined to find the mammalian ancestor in one of the Bauriamorphs; while Watson was inclined to derive the mammals directly from some Therocephalian. Then when the Gorgonopsians became better known, one thought of the possibility of the ancestor having been a primitive Gorgonopsian.



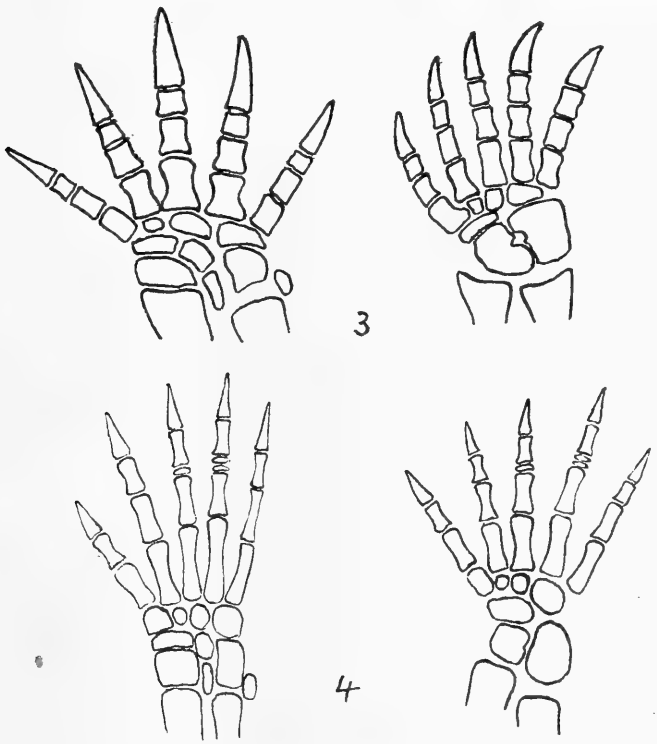
Text-fig. 2.—Anomodont Shoulder Girdle.
Shoulder girdle of *Dicynodon sollasi* Broom.

Though the Anomodonts are much too specialized to have been ancestral to the mammal, in some respects they are more mammal-like than any of the hitherto known carnivorous forms. There is a large mammal-like vomer which extends far forward into the nasal region. There is a well developed acromion process; and the digital formula is, as in man, 2, 3, 3, 3, 3 (Text-fig. 3).

Until recently nothing was known of the digital formula of the Cynodonts. Now we know that in *Thrinaxodon* (Text-fig. 4), at least, it is 2, 3, 4, 5, 3, but with one phalanx in the third toe and two in the fourth greatly reduced. This formula is the same as in the Gorgonopsians, but there the rudimentary phalanges are less reduced. In the Therocephalians and the Bauriamorphs the formula is as

in mammals, 2, 3, 3, 3, 3, with no trace of the rudimentary phalanges, and this formula also is found in the Dromasaurians.

The shoulder girdle has no acromion in the Dinocephalians, Dromasaurs, Therocephalians (Text-fig. 1), Gorgonopsians and apparently Bauriamorphs; but in Cynodonts a small acromion begins to appear, and in Anomodonts (Text-fig. 2) it is well developed. An interesting point is that an ossified sternum is found in Gorgonopsians and Anomodonts but not in Therocephalians, Dromasaurians or Cynodonts, nor apparently in Dinocephalians or Bauriamorphs. The pelvis is plate-like in Dromasaurians, Therocephalians and Gorgonopsians, and a modification of the plate-like type in Dinocephalians. In Anomodonts and Cynodonts the pelvis is becoming essentially mammal-like, an obturator foramen being developed.



Text-fig. 3.—Anomodont Manus and Pes.
Right manus and pes of *Emydopsis trigonicceps* Broom.
Text-fig. 4.—Cynodont Manus and Pes.
Right manus and pes of *Thrinaxodon liorhinus* Seeley.
(Natural size.)

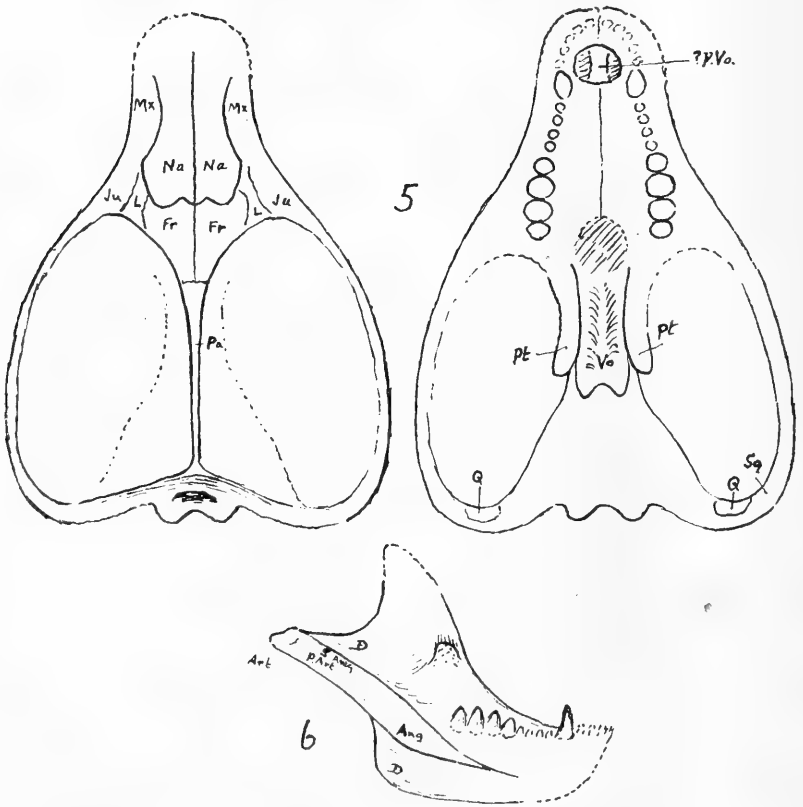
The above may be taken as a summary of the position till a few months ago, when I discovered in the Bloemfontein Museum two specimens which throw a flood of new light on the problem.

The two specimens have come from Ladybrand in the Orange Free State from the Cave Sandstone and are thus from the highest of our fossil beds and from beds which the palaeobotanists believe to be Rhaetic, but which I suspect may

be Lower Jurassic. The two specimens apparently belong to the same species. Dr. van Hoepen, the Museum Director, is naming the species and his description will probably be published shortly.

The new animal represents a new suborder, but one of which we already knew, from imperfect remains, a number of genera. Years ago I described the dentary of a very small carnivorous type under the name *Karoomys browni* believing it to be a mammal. Now it is fairly manifest that it belongs to this new suborder. Watson described an imperfect dentary under the name *Pachygenelus monus* in 1913. This also belongs to the new suborder. And so does the remarkable form described by me as *Tritheledon riconoi*.

The new animal is a small mammal-like creature, about the size of a rat, but with a relatively large head and a long tail. The skull (Text-fig. 5) is broad



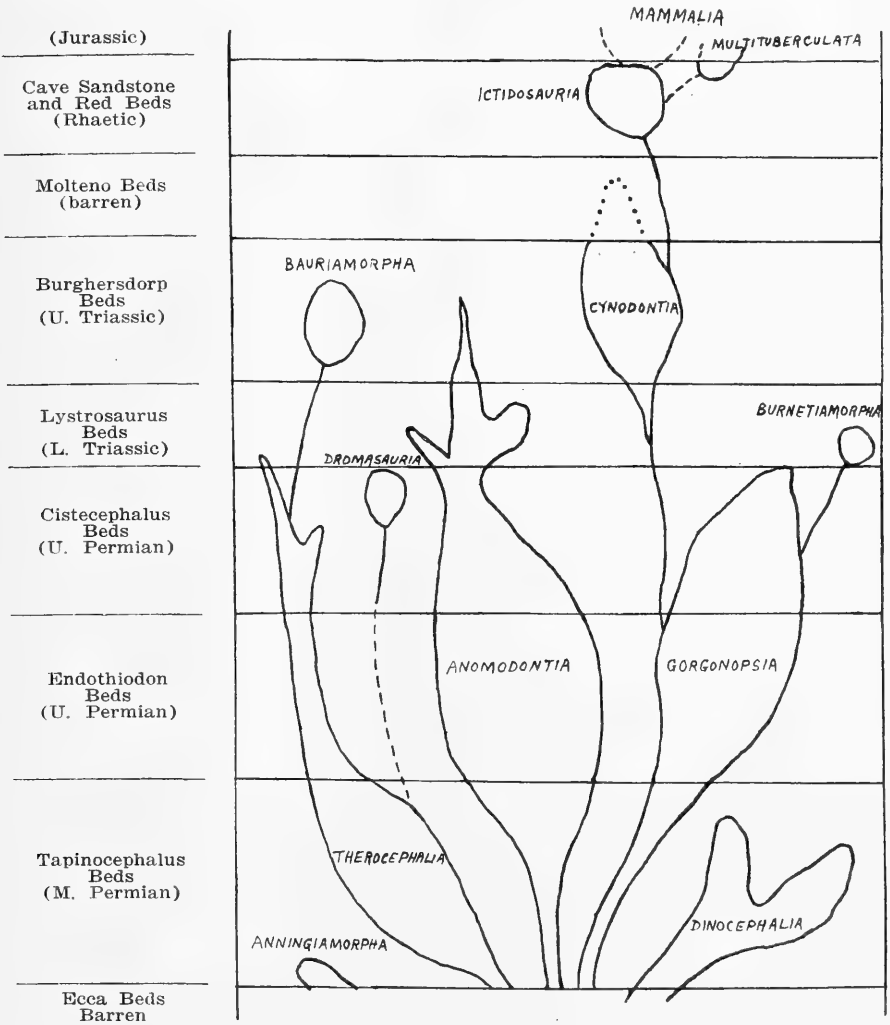
Text-fig. 5.—Upper and lower views of skull of undescribed Ictidosaurian. (× $^3/_2$ approx.)

Text-fig. 6.—Inner side of left mandible of undescribed Ictidosaurian, slightly restored.

The jaw cannot have been much longer than here indicated. There is a very powerful bony muscular attachment on inner side of dentary, apparently for part of the temporal muscle. The small bones lie in a deep groove in the dentary.

and the snout apparently very short. There is no postorbital arch or process, the small frontals forming with the parietals a long narrow median crest and there is no pineal foramen. The nasals are mammal-like; the lacrymals are small and there are no prefrontals. The maxillaries are short, but mammal-like, and the jugals form long slender suborbital zygomatic arches. The squamosals are somewhat mammal-like, but give support to small quadrates.

The palate is quite unlike that of any hitherto known Therapsid. In Therocephalians, Gorgonopsians, Bauriamorphs and Cynodonts the true vomer is small and placed well back and, fusing early with the basi-sphenoid, is much more like the "parasphenoid" of *Sphenodon* than the true mammalian vomer.



Text-fig. 7.—Distribution of the Therapsida in the Karroo Beds, with the possible connections of the groups.

And in all these groups the large pterygoids meet in the middle line and prevent the vomer from passing forward. In the new type the vomer completely separates the pterygoids and passes forward exactly as in mammals. There are large exoccipital condyles.

The lower jaw (Text-fig. 6) is so mammal-like that it was only the discovery of the small bones at the back that convinced me that the animal is not a mammal. Almost the whole jaw is formed by the dentary and the posterior end of the bone nearly articulates with the squamosal. But there is a distinct ossified articular which articulates with the small quadrate, and there are also sarangular, prearticular and angular bones, but apparently there is no coronoid or splenial.

The postcranial skeleton is not well preserved, as most of the bones are split through with the fracture, and the counter slab is lost. An interesting feature is that the scapula resembles that of *Ornithorhynchus* in having no articulation with the precoracoid.

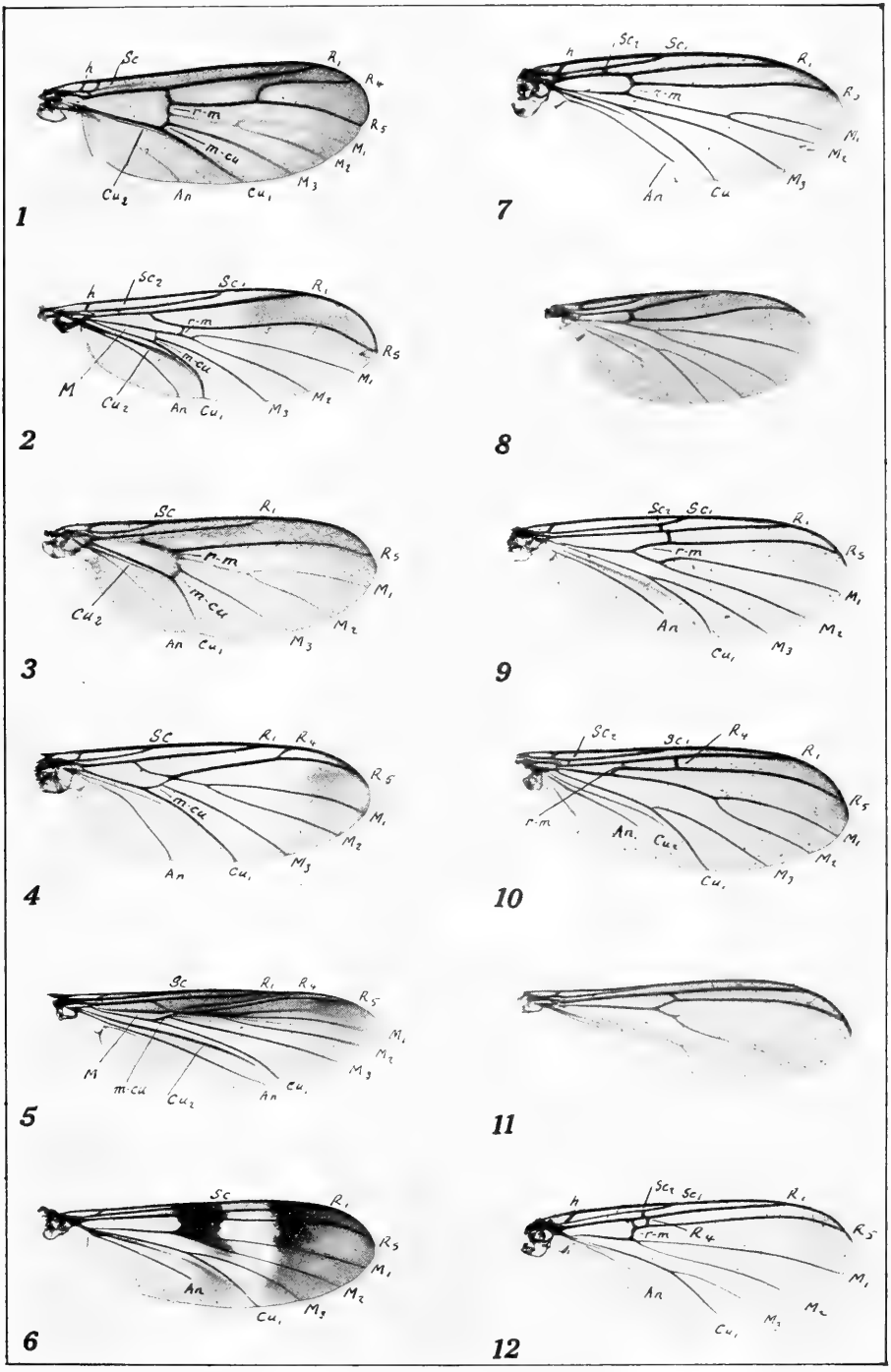
The dental formula is probably:—

$$\frac{?i^5}{?i^3}, \frac{c^1}{c^1}, \frac{pm^4}{pm^4}, \frac{m^4}{m^4}.$$

This new type, with *Karoomys*, *Pachygenelus* and *Tritheledon*, forms a new suborder of Therapsids to which the name Ictidosauria may be given. It is by far the most mammal-like of the Therapsids, and there can be no doubt that from a member of it the mammals arose. Whether one Ictidosaurian gave rise to all mammals or whether the Monotremes, Multituberculates and other mammals arose from three or four different Ictidosaurians cannot at present be decided.

Now that we have found the group from which the mammals arose, the new problem is, from which Therapsid group did the Ictidosaurian spring? And though the skull differs very markedly from that of any known Cynodont, the Cynodont affinities of the jaw are such as to suggest that the Ictidosauria have sprung from some small generalized Cynodont.

In the table here given (Text-fig. 7) are shown what I believe to be the interrelationships of the Therapsida. When one considers how difficult it is to give a completely satisfactory table of the relationships of the living mammals—how no one can give the affinities of the rodents or the aard-vark or the hyrax, or even definitely say if the artiodactyls are related to the perissodactyls—one may be forgiven for not doing better with a group that lived perhaps 200,000,000 years ago, and of which many are represented only by fragmentary skulls or jaws.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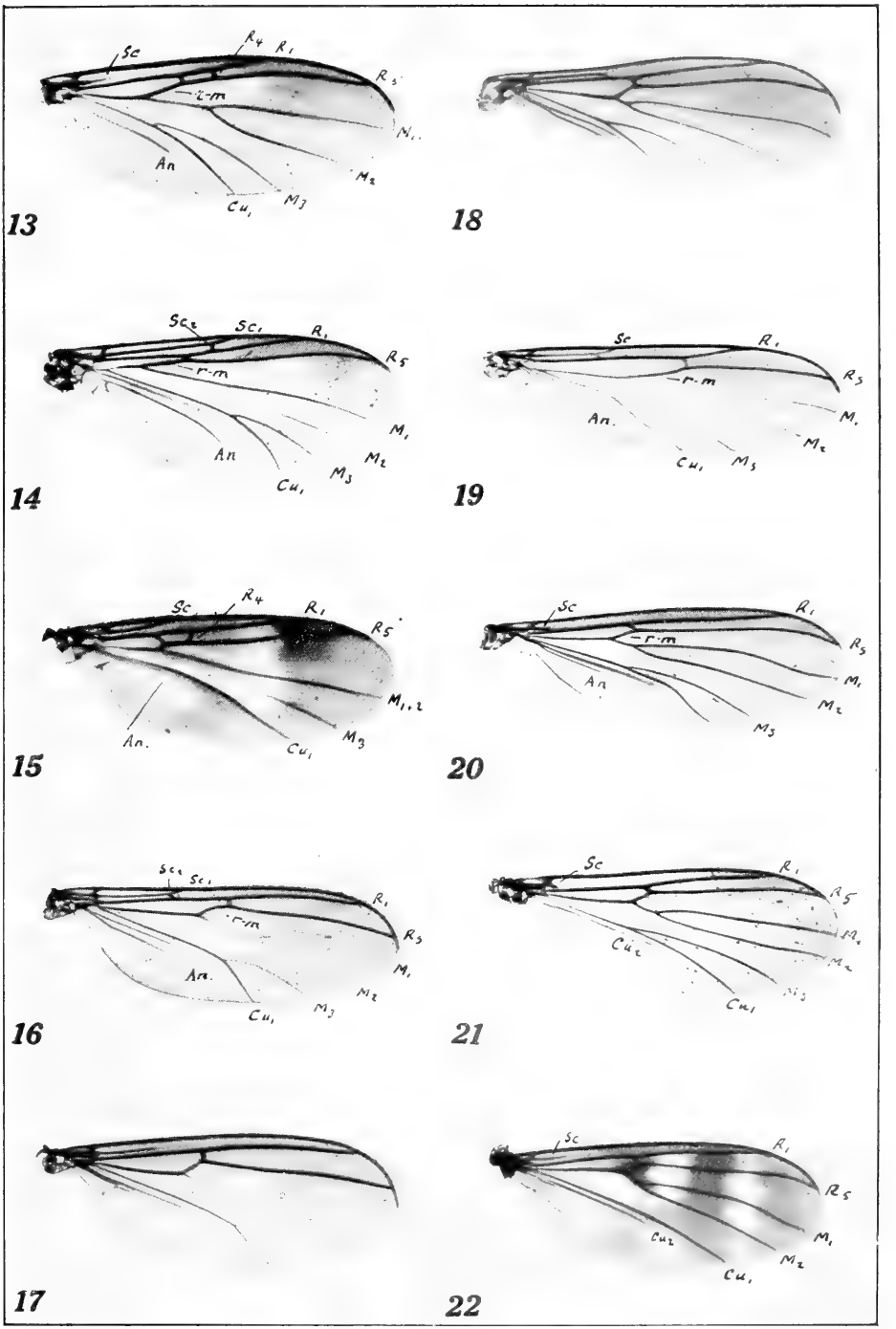
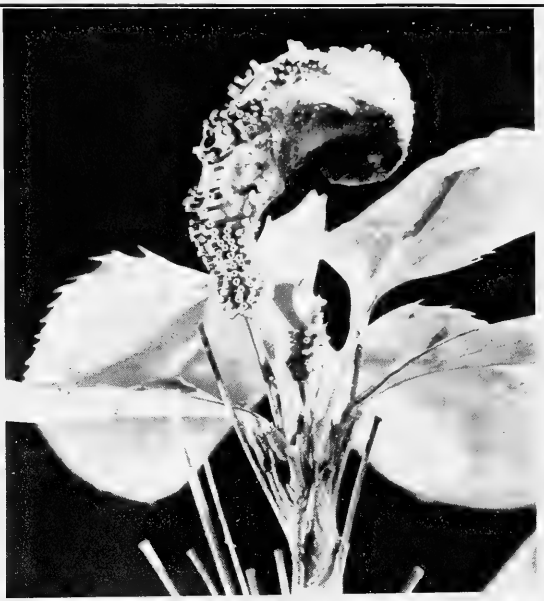
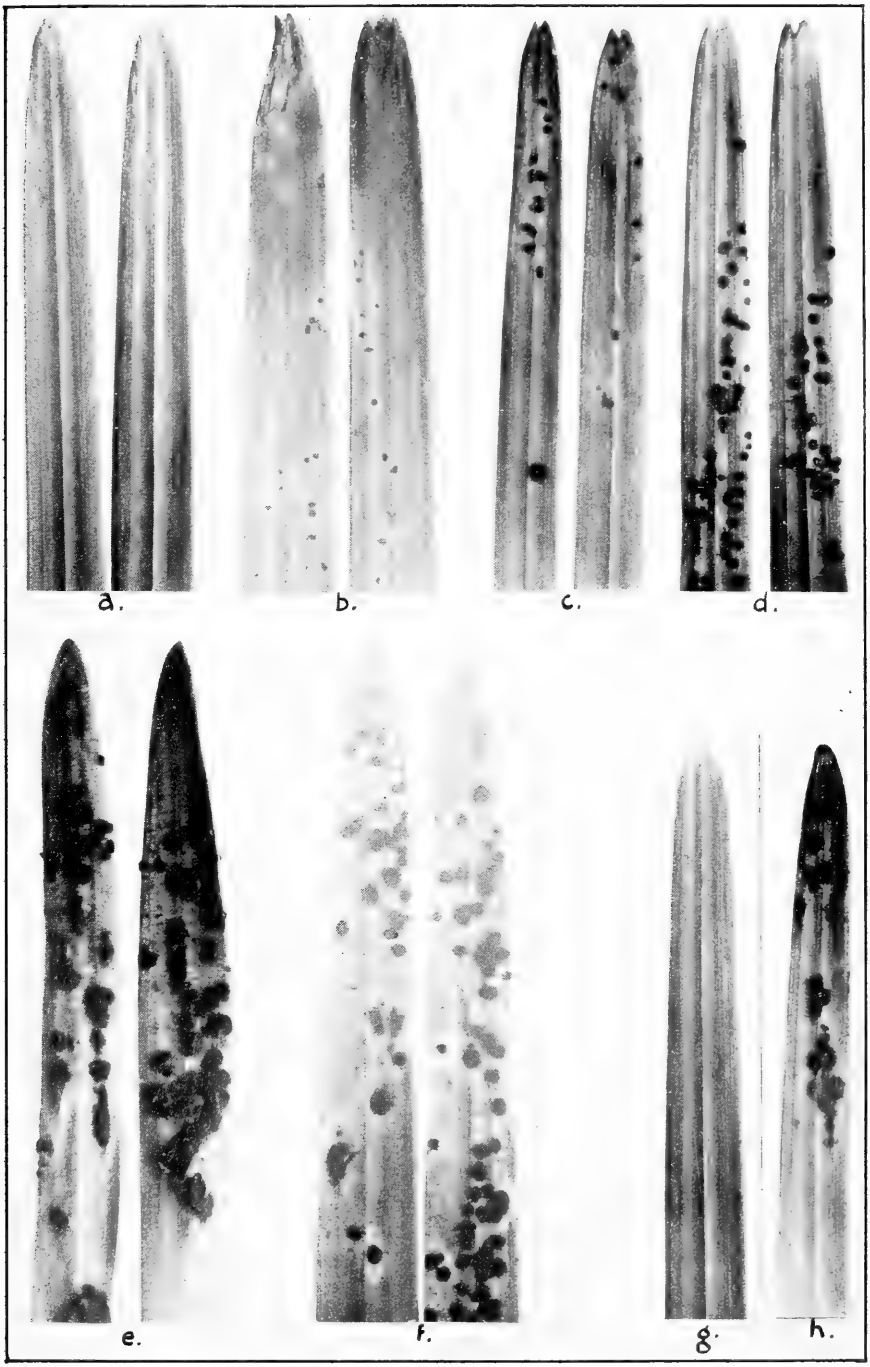


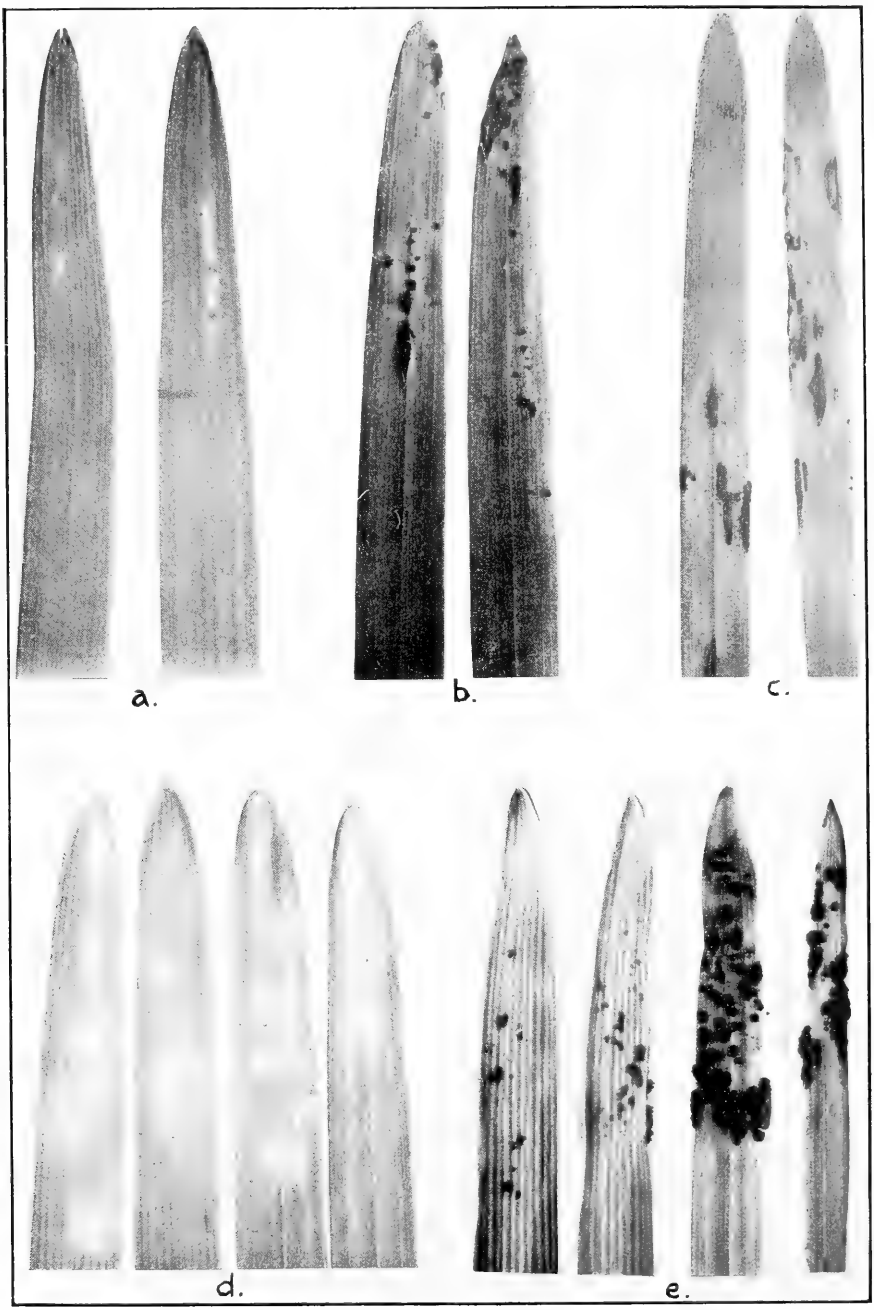
Australian Mycetophilidae.



a.

b.


a.
b.
c.
d.
e.
f.
g.
h.


a.
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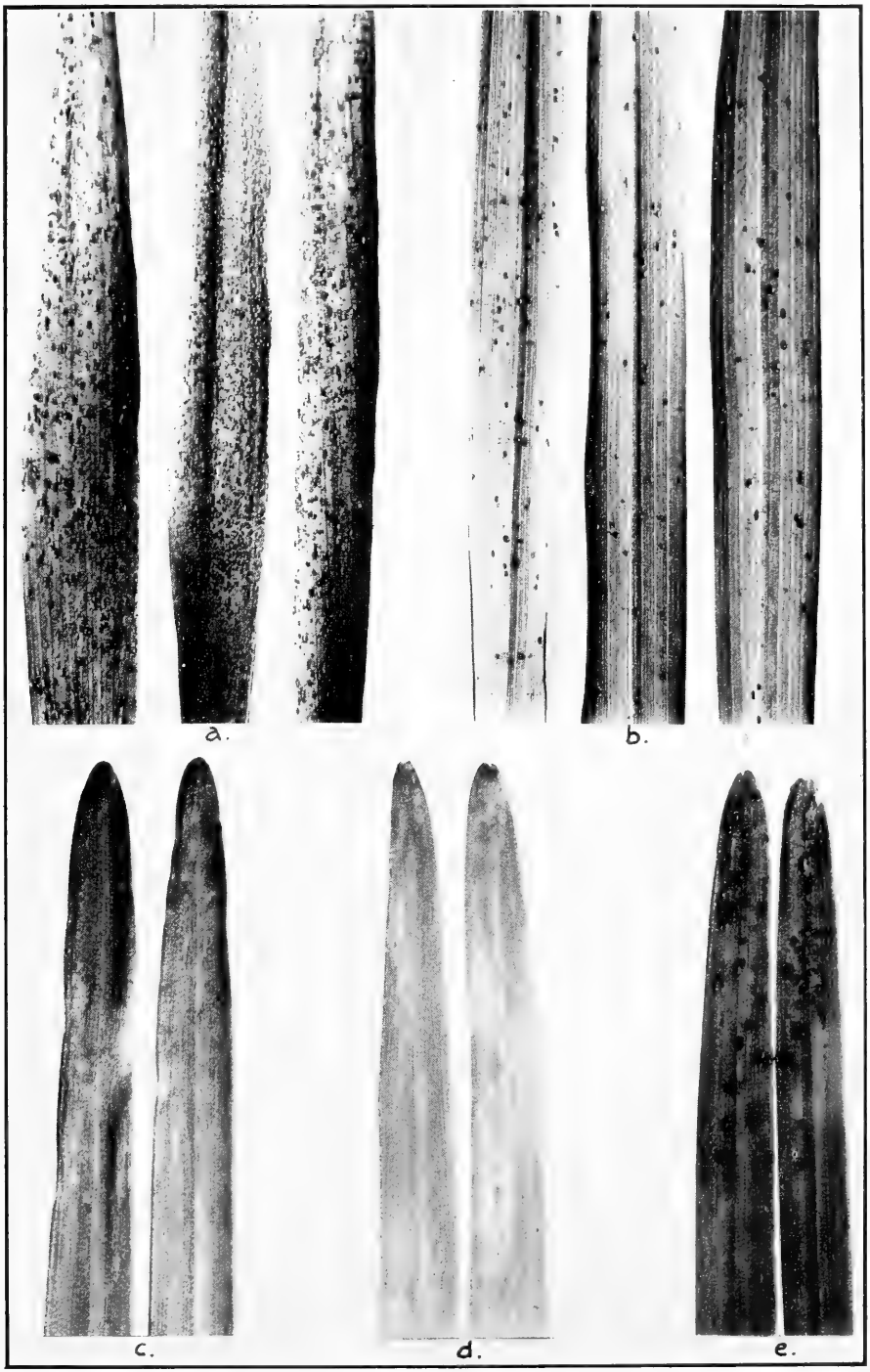
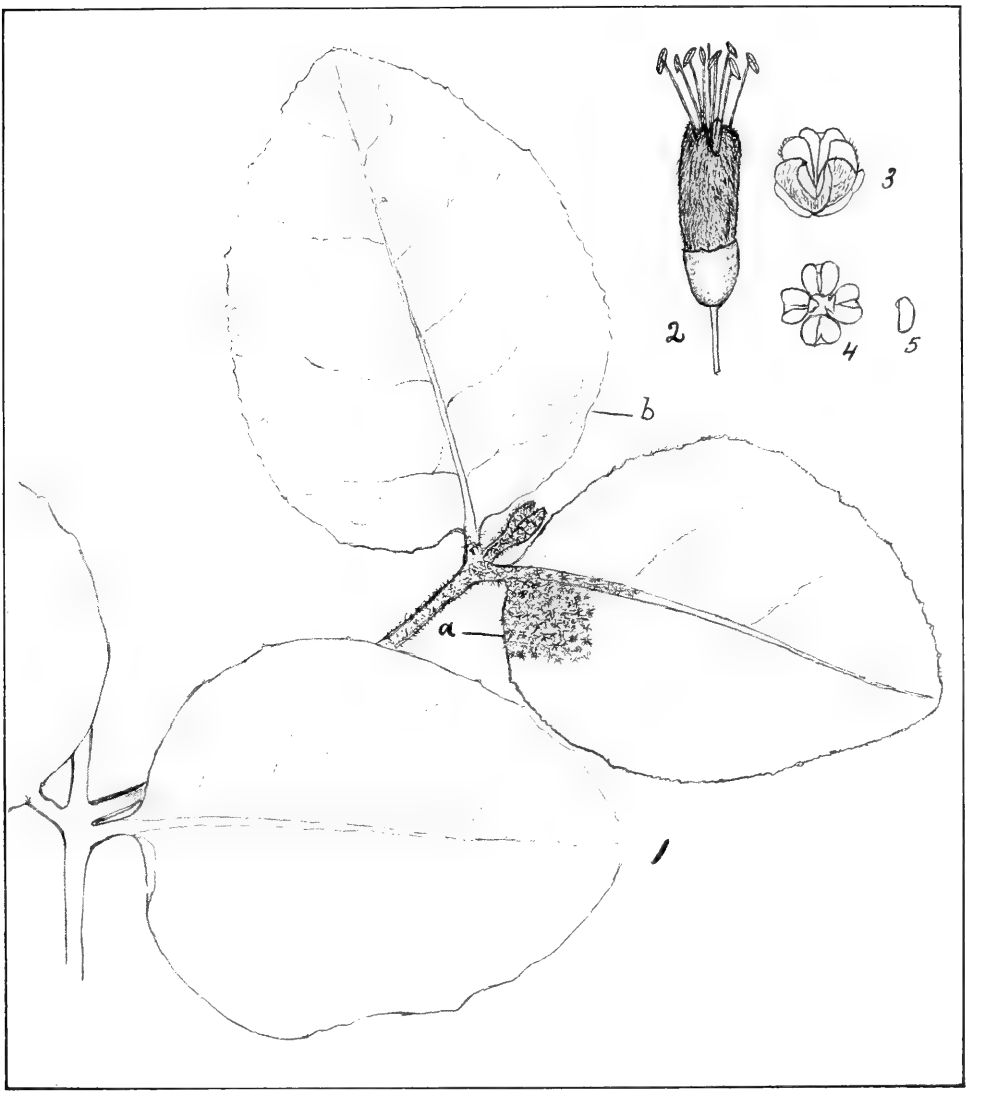
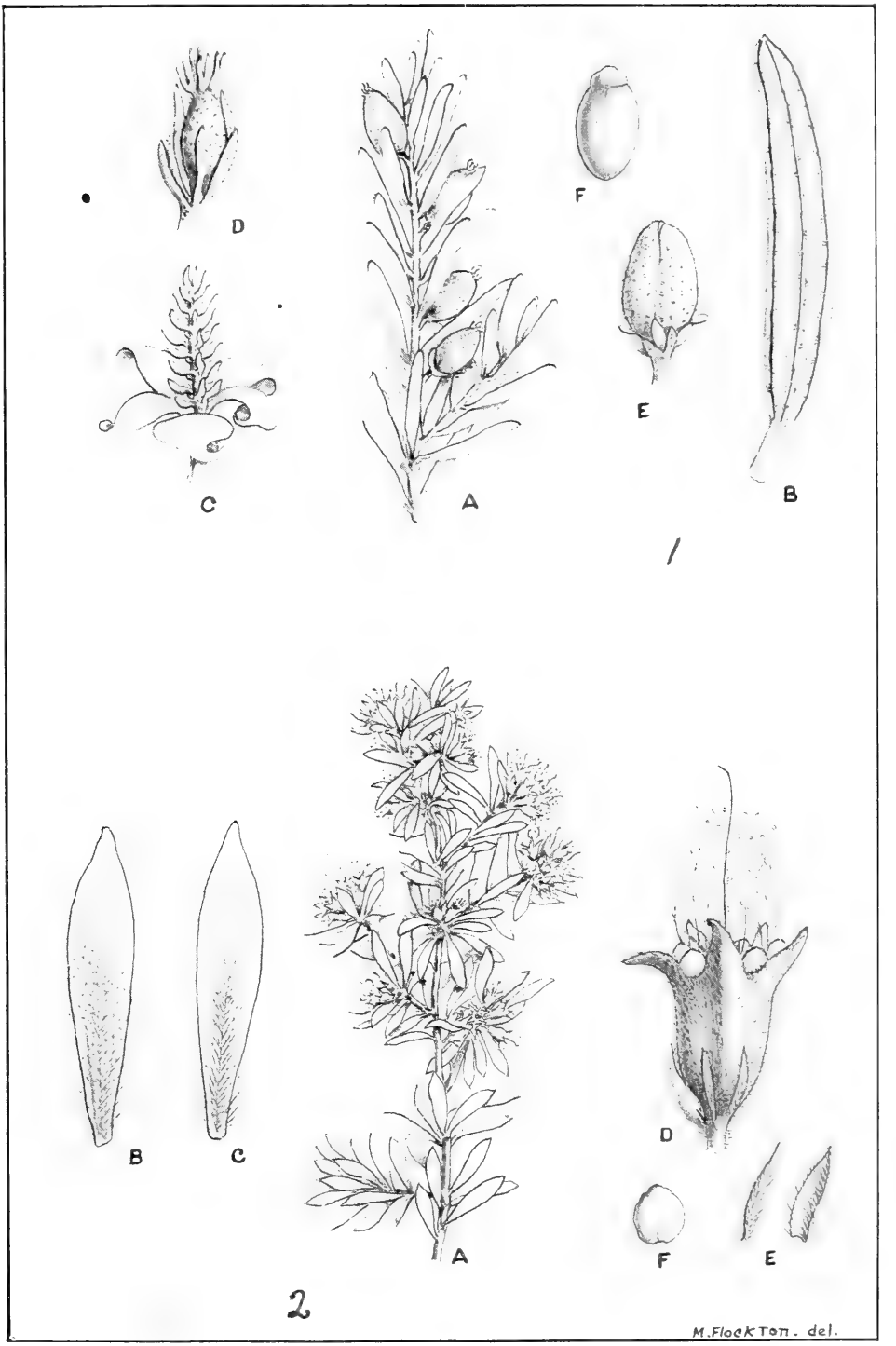
d.
e.


a.
b.
c.
d.
e.



Correa macrocalyx Blakely.



1. *Bertya oblonga* Blakely. 2. *Kunzea rupestris* Blakely.

1-7. *Goodenia Chisholmi* Blakely. 8-9. *Lasiopetalum Joyceae* Blakely.

(Issued 15th April, 1929.)

Vol. LIV. **No. 221.**
Part 1.

THE

PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES

FOR THE YEAR

1929.

Part I (Pages i-xlii).

CONTAINING THE PROCEEDINGS OF THE ANNUAL MEETING.

With one plate.
[Plate A.]

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LINNEAN MACLEAY FELLOWSHIPS ACCOUNT.

BALANCE SHEET at 31st December, 1928.

LIABILITIES.	£	s.	d.	ASSETS.	£	s.	d.
Amount bequeathed by Sir Wm. Macleay	35,000	0	0	Commonwealth Loans	9,040	0	0
Surplus Income capitalized	11,385	0	0	N.S.W. Debentures	530	0	0
				Loans on Mortgage	34,950	0	0
				Norton, Smith & Coy.	1,630	0	0
				Commercial Banking Coy., of Sydney, Ltd.	235	0	0
	£46,385	0	0		£46,385	0	0

INCOME ACCOUNT. Year Ended 31st December, 1928.

	£	s.	d.		£	s.	d.
To Salaries of Linnean Macleay Fellows	866	13	4	By Interest	2,799	1	11
„ Fellows' Subsidies	75	7	6	„ Commonwealth Loan Adjustment	0	0	5
„ Capital A/c	735	0	0				
„ General A/c	1,122	1	6				
	£2,799	2	4		£2,799	2	4

Examined and found correct. Securities produced.

F. H. RAYMENT,
Chartered Accountant (Aust.).
Sydney, 6th February, 1929.

EDWIN CHEEL,
Hon. Treasurer.
Sydney, 16th January, 1929.

BACTERIOLOGY ACCOUNT.

BALANCE SHEET at 31st December, 1928.

LIABILITIES.	£	s.	d.	ASSETS.	£	s.	d.	£	s.	d.
Amount bequeathed by Sir Wm. Macleay	12,000	0	0	Commonwealth Loans				15,300	0	0
Accumulated Income capitalized	3,800	0	0	Cash: Commercial Banking Company	445	2	1			
Income A/c at 31st December, 1928	78	17	3	Government Savings Bank	133	15	2			
								578	17	3
	£15,878	17	3					£15,878	17	3

INCOME ACCOUNT. Year Ended 31st December, 1928.

	£	s.	d.		£	s.	d.
To Expenses	82	4	6	By Balance from 1927	1,194	16	6
„ Capital A/c	1,800	0	0	„ Interest	766	5	3
„ Balance to 1929	78	17	3				
	£1,961	1	9		£1,961	1	9

Examined and found correct. Securities produced.

F. H. RAYMENT,
Chartered Accountant (Aust.).

Sydney, 16th February, 1929.

EDWIN CHEEL,
Hon. Treasurer.

Sydney, 16th January, 1929.

(Issued 15th May, 1929.)

Vol. LIV. **No. 222.**
Part 2.

THE

PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES

FOR THE YEAR

1929.

Part II (Pages 1-117.)

CONTAINING PAPERS READ IN MARCH-APRIL.

With four plates.
[Plates i-iv.]

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normal, hind femur with one long and one shorter preapical anteroventral bristle; hind tibia with four or five short anteroventral bristles, the most apical one longest, one posterodorsal bristle, and three or four irregular anterodorsal bristles. Inner cross-vein about two-fifths from base of discal cell, outer cross-vein about equally far from inner cross-vein and bend of fourth vein.

Length, 3 mm.

Type, Como, N.S.W., December, 1923, swept from flowers (H. Petersen).

All three species listed above were amongst some miscellaneous material sent to me by the late C. F. Baker from the Philippines, the whole having been collected for him by Mr. Petersen.

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(Issued 15th July, 1929.)

Vol. LIV.
Part 3.

No. 223.

THE

PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES

FOR THE YEAR

1929.

Part III (Pages 118-272.)

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[Plates v-x.]

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* Elected 12th June, 1929, in place of I. M. Mackerras, M.B., Ch.M., B.Sc., resigned.

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The MACLEAY MEMORIAL VOLUME [issued October 13th, 1893]. Royal 4to. LI. and 308 pages, with portrait, and forty-two plates. Price £2 2s.

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